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ISO/IS 10303-227

Product data representation and exchange — Application protocol: Plant spatial configuration

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**ABSTRACT:** This document specifies the Application Protocol for the exchange of the spatial configuration of plant systems with a central emphasis on piping systems. This part specifies the information required to construct a piping system, including the shape, material, and arrangements of the components of the system. It also specifies requirements for the physical aspects of other plant systems (e.g., heating, ventilation and air-conditioning) needed to design and layout the piping system.

**KEYWORDS:** application protocol, heating, ventilation, and air conditioning (HVAC), piping system, process plant, spatial configuration

**COMMENTS TO READER:** This document has been reviewed using the internal review checklist (see WG3 N1069) and the project leader checklist (see WG3 N1070) and the convener checklist (see WG3 N1071), and has been determined to be ready for this ballot cycle.

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## Foreword

ISO (International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

International Standards are drafted in accordance with the rules given in the ISO/IEC Directives, Part 3.

Draft International Standards adopted by technical committees are circulated to the member bodies for voting. Publication as an International Standard requires approval by at least 75% of the member bodies casting a vote.

Attention is drawn to the possibility that some of the elements of this part of ISO may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights.

International Standard ISO 10303-227 was prepared by Technical Committee ISO/TC 184, *Industrial automation systems and integration*, Subcommittee SC4, *Industrial data*.

This second edition of ISO 10303-227 cancels and replaces the first edition (ISO 10303-227:2000), of which it constitutes a technical revision.

This International Standard is organized as a series of parts, each published separately. The structure of this international standard is described in ISO 10303-1.

Each part of this International Standard is a member of one of the following series: description methods, implementation methods, conformance testing methodology and framework, integrated generic resources, integrated application resources, application protocols, abstract test suites, application interpreted constructs, and application modules. This part is a member of the application protocols series.

A complete list of parts of ISO 10303 is available from the Internet:

<http://www.nist.gov/sc4/editing/step/titles/>

Should further parts of ISO 10303 be published, they will follow the same numbering pattern.

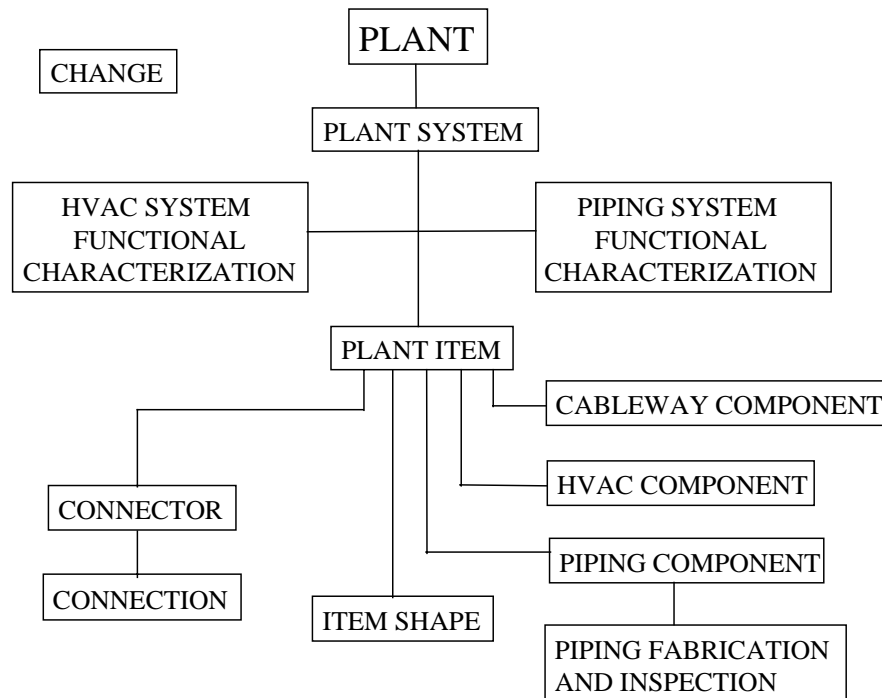
Annexes A, B, C, D, and E form a normative part of this part of ISO 10303. Annexes F, G, H, J, K, L, and M are for information only.

## Introduction

ISO 10303 is an International Standard for the computer-interpretable representation of product information and for the exchange of product data. The objective is to provide a neutral mechanism capable of describing products throughout their life cycle. This mechanism is suitable not only for neutral file exchange, but also as a basis for implementing and sharing product databases, and as a basis for archiving.

This part of ISO 10303 is a member of the application protocol series. This part of ISO 10303 specifies an application protocol (AP) for the exchange of the spatial configuration information of process plants, plant systems and ship systems. This information includes the shape, spatial arrangement and connection characteristics of piping, HVAC (heating, ventilation and air-conditioning) and cableway system components as well as the shape and spatial arrangement characteristics of other related plant systems (e.g., instrumentation and controls, and structural systems). Users of this standard should understand the basic principles and concepts of plant design, and piping, HVAC and cableway system design.

This AP specifies requirements for the exchange of information required for the design, analysis, fabrication and installation of piping components and piping systems and information on the inspection of fabricated piping. This AP specifies requirements for the exchange of information required for the design, analysis and installation of HVAC components and HVAC systems. This AP specifies requirements for the exchange of information required for the design and installation of cableway components and cableway systems. This AP also specifies requirements for the exchange of functional characteristics for HVAC and piping components and systems. The



**Figure 1 - Data planning model**

design information for a piping system may specify a pump capable of maintaining a pressure and flow rate. The design may also specify the shape limitations or requirements and the location of the pump in the system, but the design will not include sufficient information for the fabrication of the pump.

Figure 1 contains a data planning model that provides a high level description of the requirements for this application protocol, as well as the relationships between the basic data concepts. The data planning model illustrates that a plant consists of plant systems, plant systems consist of plant items and plant items may be connected to one another using connectors on the plant item. The shape and spatial arrangement of plant items are represented by the item shape. The shape representation may use constructive solid geometry (CSG), solid boundary representation (Brep) geometry, wireframe geometry, or combinations of these. The plant item shape may be represented at various levels of abstraction, from an encompassing envelope to a detailed design description. The data planning model further illustrates that the concept of change is a requirement for this application protocol. Change is applicable to each individual plant item, the relationships between plant items, and to groupings of plant items. It applies to all the concepts noted on the data planning model.

**NOTE** This part of ISO 10303 may be used in conjunction with ISO 13584 [13] to identify catalogue items and classifications.

This application protocol defines the context, scope, and information requirements for the exchange of design and layout information for a process plant, plant systems, ship systems, system components and equipment between different agents over the life cycle of the facility and specifies the integrated resources necessary to satisfy these requirements. The reasons for exchanging this information include:

- exchange of requirements from an owner to an engineering firm;
- exchange of cableway, HVAC, piping and equipment designs between a design engineer and a system engineer;
- exchange of cableway, HVAC, piping and equipment designs between a design engineer and a fabricator;
- exchange of changes to cableway, HVAC, piping and equipment designs between a design engineer and a system engineer or a fabricator;
- exchange of piping fabrication information, fabricated piping inspection results and installation information between engineering, fabrication and construction firms;
- integration of designs created by different engineers;
- detection of physical interferences of systems and components with components of other systems;
- exchange of cableway, HVAC and piping installation information between engineering and construction firms and with owner organizations;

— exchange of as-built facility and system configurations among owners, engineering firms and construction firms.

Application protocols provide the basis for developing implementations of ISO 10303 and abstract test suites for the conformance testing of AP implementations.

Clause 1 defines the scope of the application protocol and summarizes the functionality and data covered by the AP. Clause 3 lists the words defined in this part of ISO 10303 and gives pointers to words defined elsewhere. An application activity model that is the basis for the definition of the scope is provided in annex F. The information requirements of the application are specified in clause 4 using terminology appropriate to the application. A graphical representation of the information requirements, referred to as the application reference model, is given in annex G.

Resource constructs are interpreted to meet the information requirements. This interpretation produces the application interpreted model (AIM). This interpretation, given in 5.1, shows the correspondence between the information requirements and the AIM. The short listing of the AIM specifies the interface to the integrated resources and is given in 5.2. Note that the definitions and EXPRESS provided in the integrated resources for constructs used in the AIM may include select list items and subtypes which are not imported into the AIM. The expanded listing given in annex A contains the complete EXPRESS for the AIM without annotation. A graphical representation of the AIM is given in annex H. Additional requirements for specific implementation methods are given in annex C.



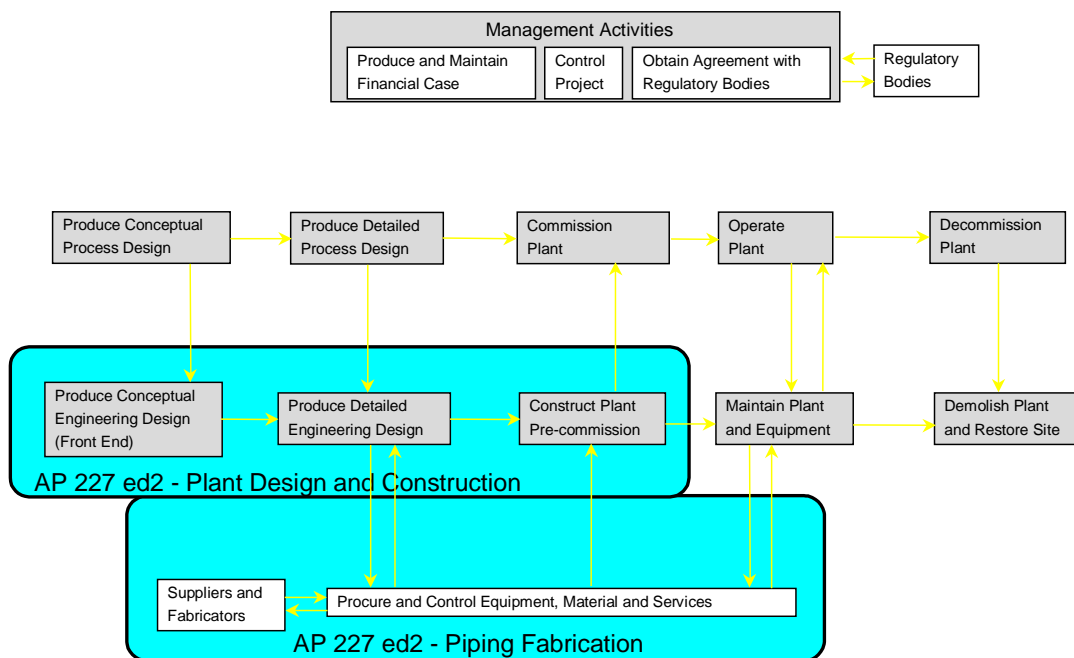
# Industrial automation systems and integration — Product data representation and exchange — Part 227: Application protocol — Plant spatial configuration

## 1 Scope

This part of ISO 10303 specifies the use of the integrated resources necessary for the scope and information requirements for the exchange of spatial configuration information of process plants, plant systems and ship systems. The spatial configuration information focuses on the shape and spatial arrangement of the components of the systems. The spatial configuration information principally supports the engineering, fabrication and installation life-cycle phases, but may be useful in the downstream life-cycle phases of operations and maintenance. This part accommodates the disciplines of plant design, system design, fabrication, inspection, installation and construction.

NOTE 1 The application activity model in annex F provides a graphical representation of the processes and information flows that are the basis for the definition of the scope of this part of ISO 10303.

NOTE 2 Figure 2 illustrates the basic life-cycle stages of a process plant. Plant life-cycle phases for which AP 227 is useful are enclosed in the rounded rectangles labeled “AP 227 ed2”.



**Figure 2 - Process plant life cycle activity coverage**

The following are within the scope of this part of ISO 10303:

- the shape and spatial arrangement of items in systems within a process plant or ship;
- explicit representation of the 3D shape of systems and components;
- explicit representation of the 3D external shape of system components and equipment.  
The representation may include envelope, outline and detailed representations as well as a parametric representation of the external shape.
- the functional configuration of HVAC and piping systems and the relationship of the functional configurations to the physical system design;
- information required for the design, analysis, fabrication and installation of piping components and piping systems;
- information on the inspection of fabricated piping;

NOTE 3 The functional configuration entails connectivity, sequencing, component size, and schedule, and may include other information, such as equipment tag numbers and requirements to perform consistency checks between the functional and physical representations of the design.

- basic engineering data as needed for spatial layout and configuration of systems;
- references to functional requirements of plant systems, such as stream data and operational characteristics;
- references to or designation of functional characteristics of components and connected equipment as required for system design;
- the identification, shape, location, and orientation of reserved areas, volumes, and space-occupying elements of a plant;
- references to specifications, standards, guidelines, or regulations for the systems, components, or connected equipment that may specify physical characteristics or performance characteristics of the system or component;

EXAMPLE 1 Physical characteristics include material and welding requirements.

EXAMPLE 2 References to standards include ISO 10303-221 [3] and ISO 13584 [13].

- the identification of catalogue information associated with a component;
- the identification of catalogues that contain component definitions;
- status of components and connected equipment and of their spatial arrangement;

NOTE Status labels are used by project management to monitor and control the execution of the project. Labels such as "preliminary", "in-work", and "released for fabrication" are used

to designate the degree of completeness or suitability for further action of the design or layout that the label is applied to.

- connections and connection requirements for cableway, HVAC and piping components and equipment;
- definition of components in sufficient detail to support the acquisition of the components;
- change request approval, notification, and verification, tracking of differences between versions of system information, and tracking of changes to plant items and attributes of plant items;

**NOTE** Only the specific change information described in this part of ISO 10303 is in scope. The change process itself is not in scope.

- specification of the chemical composition of the streams carried by the piping and HVAC systems in sufficient detail to evaluate the suitability of components for the desired process;
- data exchange;
- external reference to classification systems;
- external reference to standard parts;
- external reference to representations of standard parts.

The following are outside the scope of this part of ISO 10303:

- schematic representations;

**EXAMPLE** Schematic representations include P&IDs and process flow diagrams (PFDs).

- the contents of specifications, standards, guidelines, or regulations;
- preparation of piping specifications;
- logistics and materials management;
- specification of the chemical composition of the streams carried by the piping system in sufficient detail for process flow design;
- process design and conceptual engineering;

**EXAMPLE** Process design includes activities such as process material and heat balances, process flow diagram development, and determination of equipment sizes.

- testing, commissioning, handover, maintenance, and disposal of a plant;

- plant operating procedures;
- commercial aspects of procurement and contracting;

EXAMPLE Commercial aspects include pricing, terms and conditions, and payment schedules.

- information necessary to manage the evolution and growth of data sets through the life-cycle of a product or project other than indications of changes and approvals;
- history data;
- internal design and maintenance of equipment.

## 2 Normative references

The following normative documents contain provisions which, through reference in this text, constitute provisions of this International Standard. For dated references, subsequent amendments to, or revisions of, any of these publications do not apply. However, parties to agreements based on this International Standard are encouraged to investigate the possibility of applying the most recent editions of the normative documents indicated below. For undated references, the latest edition of the normative document referred to applies. Members of ISO and IEC maintain registers of currently valid International Standards.

ISO/IEC 8824-1:1995, *Information technology — Open systems interconnection — Abstract syntax notation one (ASN.1): Specification of basic notation*.

ISO 10303-1:1994, *Industrial automation systems and integration — Product data representation and exchange — Part 1: Overview and fundamental principles*.

ISO 10303-11:1994/Cor 1:1999, *Industrial automation systems and integration — Product data representation and exchange — Part 11: Description methods: The EXPRESS language reference manual*.

ISO 10303-21:1994/Cor 1:1996, *Industrial automation systems and integration — Product data representation and exchange — Part 21: Implementation methods: Clear text encoding of the exchange structure*.

ISO 10303-31:1994, *Industrial automation systems and integration — Product data representation and exchange — Part 31: Conformance testing methodology and framework: General concepts*.

ISO 10303-41:1994, *Industrial automation systems and integration — Product data representation and exchange — Part 41: Integrated generic resources: Fundamental of product description and support*.

ISO 10303-42:2000, *Industrial automation systems and integration — Product data representation and exchange — Part 42: Integrated generic resources: Geometric and topological representation*.

ISO 10303-43:2000, *Industrial automation systems and integration — Product data representation and exchange — Part 43: Integrated generic resources: Representation structures*.

ISO 10303-44:2000, *Industrial automation systems and integration — Product data representation and exchange — Part 44: Integrated generic resources: Product structure configuration*.

ISO 10303-45:1998, *Industrial automation systems and integration — Product data representation and exchange — Part 45: Integrated generic resources: Materials*.

ISO 10303-46:1994, *Industrial automation systems and integration — Product data representation and exchange — Part 46: Integrated generic resources: Visual presentation*.

ISO 10303-47:1997, *Industrial automation systems and integration — Product data representation and exchange — Part 47: Integrated generic resources: Shape variation*.

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*tolerances.*

ISO 13584-24:1995, *Industrial automation systems and integration — Parts library — Part 24: Logical model of supplier library.*

ISO 13584-42:1995, *Industrial automation systems and integration — Parts library — Part 42: Methodology for structuring part families.*

### 3 Terms, definitions, and abbreviations

#### 3.1 Terms defined in ISO 10303-1

This part of ISO 10303 makes use of the following terms defined in ISO 10303-1:

- abstract test suite (ATS);
- application;
- application activity model (AAM);
- application interpreted model (AIM);
- application protocol (AP);
- application reference model (ARM);
- conformance class;
- implementation method;
- integrated resource;
- product;
- product data;
- protocol information and conformance statement (PICS);
- unit of functionality (UoF).

#### 3.2 Terms defined in ISO 10303-31

This part of ISO 10303 makes use of the following terms defined in ISO 10303-31:

- conformance testing;
- implementation under test (IUT).

#### 3.3 Other definitions

For the purposes of this part of ISO 10303, the following definitions apply:

##### 3.3.1 actual

descriptive adjective that, when applied to an item, indicates that the item exists at some time in the real world. An actual plant item (see **3.3.31**) has properties that can be measured or observed

NOTE 1 The terms actual, planned (see **3.3.31**), and required (see **3.3.41**) loosely reflect life-cycle stages of an item.

NOTE 2 Within the scope of this part of ISO 10303, being actual can be specified for an item that is:

- a plant item;
- an association between plant items such as a connection;
- an activity or an association between a plant item and an activity;
- a possession of a property by a plant item or activity.

NOTE 3 An item cannot be both actual and planned (see **3.3.31**). An actual item can be the realization of an planned item.

### **3.3.2 assembly**

a set of items that have a relationship to each other apart from being members of the same set

NOTE Within the scope of this part of ISO 10303, an assembly can be items that are plant items (see **3.3.32**).

### **3.3.3 basic engineering data**

parameters and descriptions that specify design (see **3.3.11**) characteristics and boundaries for the plant item (see **3.3.32**) that are required to support piping system (see **3.3.30**) design

EXAMPLE Piping system design parameters and descriptions include design temperature, design pressure, design codes, and weights.

### **3.3.4 branch**

a portion of a piping system (see **3.3.30**) that diverges or divides from the main flow path

NOTE A branch may have a different identifier from that of the main flow path.

### **3.3.5 catalogue**

a collection (see **3.3.6**) of items or an electronic or paper document that contains information about a collection of items

NOTE Within the scope of this part of ISO 10303, a catalogue can be a collection of typical or reference plant items (see **3.3.32**), that the definition of a specific occurrence of a plant item in the design (see **3.3.11**) of a process plant (see **3.3.37**) can be selected from.

### **3.3.6 collection**

a set of things that do not have any relationship to each other apart from being members of the same set

NOTE Within the scope of this part of ISO 10303, a collection can be items that are plant items (see **3.3.32**).

### **3.3.7 component**

an item that may be part of another item

NOTE 1 Within the scope of this part of ISO 10303, an item that is a component can be part of a functional (see 3.3.13) or physical (see 3.3.24) plant item (see 3.3.32) or part of a process material (see 3.3.36) that is a mixture.

NOTE 2 A component can itself have components.

### 3.3.8 connection

an association between two items that enables the flow of process material (see 3.3.36), energy, mechanical loads, or signals between them or constrains their relative positions

NOTE 1 Within the scope of this part of ISO 10303, a connection can be between either functional (see 3.3.13) or physical (see 3.3.24) plant items (see 3.3.32).

NOTE 2 A connection can be the result of a physical (see 3.3.24) joining.

NOTE 3 A functional connection can exist between two plant items (see 3.3.32) without a physical (see 3.3.24) joining of the plant items.

### 3.3.9 connector

a physical (see 3.3.24) or functional (see 3.3.13) property of a plant item (see 3.3.32) that links it to another plant item, or to a compatible connector on another plant item. This linkage enables the flow of energy, mechanical loads, process material (see 3.3.36), or signals through the connected plant items

### 3.3.10 construction material

the substance or substances that a physical (see 3.3.24) plant item (see 3.3.32) is made from

### 3.3.11 design

a representation (see 3.3.40) of a process plant (see 3.3.37), portion of a process plant, or plant - item (see 3.3.32), that is created for a specific purpose and uses a consistent syntax and symbology

NOTE A PFD is a design that represents the flow and reaction of process materials (see 3.3.36). A P&ID is a design that represents the logical functionality of a piping system (see 3.3.30). A three-dimensional geometric model is a design that represents the physical (see 3.3.24) shape and arrangement of the components (see 3.3.7) of a process plant (see 3.3.37) or plant system (see 3.3.33).

### 3.3.12 equipment

a plant item (see 3.3.32) that carries out an operation and that is treated as a single item for the purpose of design (see 3.3.11), acquisition, or operation

NOTE An equipment has both physical (see 3.3.24) and functional (see 3.3.13) aspects.

### 3.3.13 functional

descriptive adjective that, when applied to an item, refers to the actions, activities, or capabilities, that the item provides or may provide to fulfill a purpose

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NOTE In the process plant industry, a plant item (see **3.3.32**) that provides functional capability in a process plant (see **3.3.37**) is typically denoted by a tag number.

### **3.3.14 functional characteristics**

nomenclature, codes, and named values that describe or specify the performance or behaviour of a plant item (see **3.3.32**)

EXAMPLE Functional characteristics include flow rates, operating pressure, and maximum temperature.

### **3.3.15 functional requirements**

nomenclature, codes, and named values that describe or specify the performance or behaviour to be met by a plant item (see **3.3.32**)

### **3.3.16 instrument**

an individually identifiable plant item (see **3.3.32**) or combination of plant items, that is part of a system that monitors or controls a process plant (see **3.3.37**)

EXAMPLE Instruments include items such as control valves, sensors, and gauges.

### **3.3.17 insulation**

a quantity of matter or space that provides resistance to the flow of heat, electricity, sound, or mechanical vibration

### **3.3.18 line**

a logical component (see **3.3.7**) of a piping system (see **3.3.30**) that is composed of a collection (see **3.3.6**) of line segments (see **3.3.19**)

NOTE Further explanation of lines is provided in K.7.

### **3.3.19 line segment**

an element of a line (see **3.3.18**)

NOTE Further explanation of line segments is provided in K.7.

### **3.3.20 line segment termination**

one of two logical end-points of a line segment (see **3.3.19**)

NOTE Lines (see **3.3.18**) are composed of line segments (see **3.3.19**). Line segments are connected through line segment terminations.

### **3.3.21 line segment termination connection**

a logical linkage between two line segments (see **3.3.19**) or between a line segment and a plant item (see **3.3.32**)

### **3.3.22 material**

a quantity of matter

### **3.3.23 material stream**

a flow of process material (see **3.3.36**) past a defined point along a path

### **3.3.24 physical**

descriptive adjective that, when applied to an item, refers to a set of characteristics, properties, or traits of the item

**EXAMPLE** Characteristics include weight, size, and location and orientation of the item.

**NOTE** In the process plant industry, a physical object that is, or may be, installed as a plant item (see **3.3.32**), and can be identified by a serial number.

### **3.3.25 pipe**

a plant item (see **3.3.32**) that is hollow and approximately cylindrical, that may have a constant cross-section along its extent, and that conveys fluid, vapour, or particulate material (see **3.3.22**)

**NOTE** Heating, ventilation, and air conditioning (HVAC) duct that has a rectangular cross section is not a pipe.

### **3.3.26 pipe fitting**

a plant item (see **3.3.32**) that is used, or is intended to be used, to join or terminate pipes (see **3.3.25**) or other items in a piping system (see **3.3.30**) or equipment (see **3.3.12**) connectors (see **3.3.9**), or to provide changes of pipe direction or branching within a piping system

### **3.3.27 piping and instrumentation diagram**

a piping and instrumentation diagram schematic representation (see **3.3.40**) that consists, as a minimum, of the functional (see **3.3.13**) connection (see **3.3.8**) and assembly (see **3.3.2**) of plant items (see **3.3.32**), and the identification of principal plant items

**NOTE** The piping and instrumentation diagram can also present the functional (see **3.3.13**) and physical (see **3.3.24**) aspects of plant items (see **3.3.32**).

### **3.3.28 piping class**

a functional (see **3.3.13**) performance envelope defined by a set or range of common physical (see **3.3.24**) properties, and an identification of the pipes (see **3.3.25**), pipe fittings (see **3.3.26**), and valves that have these properties

**EXAMPLE 1** Piping classes include stainless steel, cast iron, and carbon steel.

**EXAMPLE 2** Physical properties of a piping class include diameter, pressure, and temperature.

### **3.3.29 piping specification**

a definition of various aspects of a piping system (see **3.3.30**). It is also used to refer to a document or electronic file that contains such a definition

**NOTE** Piping system (see **3.3.30**) aspects that may be included in a piping specification include design (see **3.3.11**) pressures and temperatures, piping construction materials (see **3.3.10**), pipe wall thicknesses or schedules, types of fittings to be used, types of valves and flanges, valve and flange pressure rating requirements, and fabrication, examination,

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testing, inspection, cleaning, and installation requirements, including the requirements for seismic installations, where applicable.

### **3.3.30 piping system**

a plant system (see 3.3.33) that performs a transport function, and that is composed primarily of pipes (see 3.3.25), pipe fittings (see 3.3.26), and valves subject to the same set or sets of design (see 3.3.11) conditions

### **3.3.31 planned**

descriptive adjective that, when applied to an item, indicates that an item that has been designed or predicted

NOTE 1 The terms actual (see 3.3.1), planned (see 3.3.31), and required (see 3.3.41) loosely reflect life-cycle stages of an item.

NOTE 2 Within the scope of this part of ISO 10303, being planned can be specified for an item that is:

- a plant item (see 3.3.32);
- an association between plant items such as a connection (see 3.3.8);
- an activity or an association between a plant item and an activity;
- a possession of a property by a plant item or activity.

NOTE 3 An item cannot be both actual (see 3.3.1) and planned. An actual item can be the realization of a planned item.

### **3.3.32 plant item**

a physical (see 3.3.24) object or volume of space that is, or is intended to be, a part of a process plant (see 3.3.37). A plant item can be an assembly (see 3.3.2) of other plant items. A plant item has both physical (see 3.3.24) and functional (see 3.3.13) aspects

NOTE If a plant item is a volume of space, it may or may not contain other plant items.

### **3.3.33 plant system**

a part of a process plant (see 3.3.37) that provides or performs, or is intended to provide or perform, a service or function contributing to, or enabling the operation of, a process plant. A plant system consists of an assembly (see 3.3.2) of one or more plant items (see 3.3.32). A plant system has both physical (see 3.3.24) and functional (see 3.3.13) aspects

### **3.3.34 process activity**

an activity that transforms or transports process material (see 3.3.36) between its input to a process plant (see 3.3.37) as feed stock and its output from a process plant as a product or waste

NOTE The transformation can be a change of physical (see 3.3.24) state, a physical separation or mixing, or a biological or chemical process.

**3.3.35 process flow diagram**

a schematic representation (see **3.3.40**) that consists, as a minimum, of the connection of process activities (see **3.3.34**) by material streams (see **3.3.23**) and the identification of plant items (see **3.3.32**) that perform the process activities

NOTE 1 The process activities (see **3.3.34**) shown on a process flow diagram can also be called unit operations.

NOTE 2 The process flow diagram can also present:

- properties of process activities (see **3.3.34**) and material streams (see **3.3.23**) for particular cases;
- measurements that are made upon process activities and material streams;
- the flow of signals between sensors, controllers, and actuators;
- the control logic that is implemented by a controller.

**3.3.36 process material**

the material (see **3.3.22**) that is transformed or transported by a process activity (see **3.3.34**)

**3.3.37 process plant**

an assembly (see **3.3.2**) of one or more plant systems (see **3.3.33**) and plant items (see **3.3.32**) that can, or is intended to perform, a chemical, physical (see **3.3.24**) or transport process. A process plant is identified as a single unit for the purposes of management and ownership. A process plant has both physical and functional (see **3.3.13**) aspects

**3.3.38 range of values**

a specification of a value range for a given dimension, parameter, or nominal size, for the purpose of defining a family of plant items (see **3.3.32**)

NOTE This is done by specifying two dimensional values for a given parameter. One dimension has a name with a value of minimum\_<parameter name>, such as minimum\_flange\_inside\_diameter. The other dimension has a name with a value of maximum\_<parameter name>, such as maximum\_flange\_inside\_diameter.

**3.3.39 range value**

an indication of variation of a dimension, parameter, or nominal size on an actual physical (see **3.3.24**) plant item (see **3.3.32**). A range value is not a toleranced dimension. A range value, like the range of values (see **3.3.38**), has a minimum and maximum value. It does not, however, indicate a family of plant items

NOTE The attributes that use range values in 4.2 are differentiated from those attributes that use range of values (see **3.3.38**) by a explanatory note that follows the attribute definition.

EXAMPLE Insulation (see **3.3.17**) may be described as 6 inches thick, but in reality it may be 5-7 inches thick. Range values permit this to be specified.

### **3.3.40 representation**

a description, drawing, or depiction of something

### **3.3.41 required**

descriptive adjective that, when applied to an item, indicates that an item is essential or necessary, i.e., it has to be provided to satisfy a functional (see **3.3.13**) need

NOTE 1 The terms actual (see **3.3.1**), planned (see **3.3.31**), and required loosely reflect life-cycle stages of an item.

NOTE 2 Within the scope of this part of ISO 10303, being required can be specified for an item that is:

- a plant item (see **3.3.32**);
- an association between plant items such as a connection (see **3.3.8**);
- an activity or an association between a plant item and an activity;
- a possession of a property by a plant item or activity.

### **3.3.42 site**

an area of land or water that one or more process plants (see **3.3.37**) is or may be situated on

### **3.3.43 spatial configuration**

the location, orientation, and relative position of the components (see **3.3.7**) of a plant system (see **3.3.33**)

## **3.4 Abbreviations**

For the purposes of this part of ISO 10303, the following abbreviations apply:

AAM	application activity model
AE	architectural engineering
AEC	architecture, engineering, and construction
AIC	application interpreted construct
AIM	application interpreted model
AISC	American Institute of Steel Construction
ANSI	American National Standards Institute
AP	application protocol

ARM	application reference model
ASTM	American Society for Testing and Materials
ATS	abstract test suite
Brep	boundary representation
BOP	bottom of pipe
CAD	computer-aided design
CC	conformance class
COP	centre of pipe
CSG	constructive solid geometry
ECN	engineering change notice
EPA	Environmental Protection Agency
FDA	Food and Drug Administration
GIS	geographic information system
GUID	globally unambiguous identifier
HVAC	heating, ventilation, and air conditioning
id	identifier
ICOM	input, control, output, or mechanism
IEC	International Electrotechnical Commission
ISO	International Organization for Standardization
OSHA	Occupational Safety and Health Administration
PFD	process flow diagram
P&ID	piping and instrumentation diagram
PICS	protocol information and conformance statement
PIEBASE	Process Industry Executive for achieving Business Advantage using Standards for data Exchange
PSI	pounds per square inch
UoF	unit of functionality



## 4. Information requirements

This clause specifies the information required for the exchange of plant spatial configuration information between application systems.

The information requirements are specified as a set of units of functionality, application objects, and application assertions. These assertions pertain to individual application objects and to relationships between application objects. The information requirements are defined using the terminology of the subject area of this application protocol.

NOTE 1 A graphical representation of the information requirements is given in annex G.

NOTE 2 The information requirements correspond to those of the activities identified as being in the scope of this application protocol in annex F.

NOTE 3 The mapping table specified in 5.1 shows how the integrated resources are used to meet the information requirements of this application protocol. The use of the integrated resources introduces additional requirements that are common to application protocols.

## 4.1. Units of functionality

This subclause specifies the UoFs for the plant spatial configuration application protocol. This part of ISO 10303 specifies the following units of functionality:

- cableway\_component\_characterization UoF;
- change\_information UoF;
- connection UoF;
- connector UoF;
- hvac\_component\_characterization UoF;
- hvac\_system\_functional\_characterization UoF;
- hybrid\_shape\_representation UoF;
- piping\_component\_characterization UoF;
- piping\_inspection UoF;
- piping\_system\_functional\_characterization UoF;
- plant\_characterization UoF;
- plant\_csg\_shape\_representation UoF;
- plant\_item\_characterization UoF;
- shape UoF;
- site\_characterization UoF.

The units of functionality and a description of the functions that each UoF supports are given below. The application objects included in the UoFs are defined in 4.2.

### 4.1.1. cableway\_component\_characterization UoF

The cableway\_component\_characterization UoF describes the physical representation of cableway systems and elements. This UoF extends the plant\_characterization UoF for characterization of cableway systems and extends the plant\_item\_characterization UoF for representation of cableway components. The geometry of cableway components is specified using the shape UoF.

The following application objects are used by the cableway\_component\_characterization UoF:

- Cable;
- Cableway\_component;
- Cableway\_connector;
- Cableway\_fitting;
- Cableway\_piece;
- Cableway\_size\_description;
- Conduit;
- Conduit\_size\_description;
- Raceway;
- Raceway\_lane;
- Raceway\_size\_description.

#### **4.1.2. change\_information UoF**

The change\_information UoF describes information such as the design change requests and approvals for modifications to Plant objects, Plant\_item objects, Plant\_system objects, and other components associated with the Plant.

The following application objects are used by the change\_information UoF:

- Change;
- Change\_approval;
- Change\_item;
- Change\_life\_cycle\_stage;
- Change\_life\_cycle\_stage\_sequence;
- Change\_life\_cycle\_stage\_usage;
- Changed\_line\_assignment;
- Changed\_line\_branch\_connection;
- Changed\_line\_plant\_item\_branch\_connection;
- Changed\_line\_plant\_item\_connection;
- Changed\_line\_to\_line\_connection;

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- Changed\_piping\_specification;
- Changed\_piping\_system\_line;
- Changed\_piping\_system\_line\_segment;
- Changed\_piping\_system\_line\_segment\_termination;
- Changed\_planned\_physical\_plant;
- Changed\_plant;
- Changed\_plant\_item;
- Changed\_plant\_item\_collection;
- Changed\_plant\_item\_connection;
- Changed\_plant\_item\_connector;
- Changed\_plant\_item\_location;
- Changed\_plant\_item\_shape;
- Changed\_plant\_process\_capability;
- Changed\_plant\_system;
- Changed\_reference\_geometry;
- Changed\_required\_material\_description;
- Changed\_site;
- Changed\_site\_feature;
- Changed\_sited\_plant;
- Changed\_sub\_plant\_relationship.

### **4.1.3. connection UoF**

The connection UoF describes the physical linkage or connectivity between Plant\_item objects. Plant\_item objects have connectors. Two connectors of a compatible type are attached to form a connection. The sequence of connections establishes the physical connectivity of items within Plant\_system objects.

The following application objects are used by the connection UoF:

- Connection\_definition;

- Electricity\_transference;
- Flexible\_connection;
- Fluid\_transference;
- Functional\_connection\_definition\_satisfaction;
- Functional\_connection\_occurrence\_satisfaction;
- Load\_transference;
- Locked\_orientation\_connection;
- Plant\_item\_connection;
- Plant\_item\_connection\_occurrence.

#### **4.1.4. connector UoF**

The connector UoF is the information about the part of a Plant\_item that is intended to interconnect with another Plant\_item. This UoF describes the physical features of Plant\_item objects that are designed to connect or mate with a similar physical feature on another Plant\_item object.

The following application objects are used by the connector UoF:

- Branch\_hole;
- Buttweld;
- Catalogue\_connector;
- Clamped;
- Connector\_definition;
- Cross\_section\_flat\_oval;
- Cross\_section\_non\_standard;
- Cross\_section\_radiused\_corner;
- Cross\_section\_rectangular;
- Cross\_section\_round;
- Cross\_section\_triangular;
- Electrical\_connector;
- Female\_end;

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- Flanged;
- Flanged\_end;
- Flared\_end;
- Functional\_connector;
- Functional\_connector\_definition\_satisfaction;
- Functional\_connector\_occurrence\_satisfaction;
- Grooved\_end;
- Hvac\_branch\_connection;
- Hvac\_connector;
- Hvac\_connector\_service\_characteristic;
- Hvac\_cross\_section;
- Hvac\_plant\_item\_branch\_connector;
- Hvac\_plant\_item\_connector;
- Male\_end;
- Node;
- Physical\_connector;
- Piping\_connector;
- Piping\_connector\_service\_characteristic;
- Plant\_item\_connector;
- Plant\_item\_connector\_occurrence;
- Pressure\_fit;
- Service\_operating\_case;
- Socket;
- Structural\_load\_connector;
- Stub\_in;
- Threaded.

#### 4.1.5. **hvac\_component\_characterization UoF**

The `hvac_component_characterization` UoF describes the physical representation of HVAC systems and elements. This UoF extends the `plant_item_characterization` UoF for representation of `Hvac_component` objects. The geometry of `Hvac_component` objects is specified using the `shape` UoF.

The following application objects are used by the `hvac_component_characterization` UoF:

- `Hvac_access_opening`;
- `Hvac_bend`;
- `Hvac_component`;
- `Hvac_component_thickness`;
- `Hvac_coupling`;
- `Hvac_elbow_90deg_reducing`;
- `Hvac_elbow_centred`;
- `Hvac_elbow_mitre`;
- `Hvac_end_fitting`;
- `Hvac_equipment`;
- `Hvac_fitting`;
- `Hvac_flow_control_device`;
- `Hvac_gasket`;
- `Hvac_instrument`;
- `Hvac_offset_centred`;
- `Hvac_offset_ogee_centred`;
- `Hvac_takeoff`;
- `Hvac_transition`;
- `Hvac_transition_slanted`;
- `Splitter`.

#### **4.1.6. hvac\_system\_functional\_characterization UoF**

The hvac\_system\_functional\_characterization UoF describes the functional representation of HVAC systems and elements. It extends the plant\_characterization UoF.

The following application objects are used by the hvac\_system\_functional\_characterization UoF:

- Hvac\_plant\_item\_branch\_connection;
- Hvac\_plant\_item\_connection;
- Hvac\_plant\_item\_termination;
- Hvac\_section\_branch\_termination;
- Hvac\_section\_segment;
- Hvac\_section\_segment\_insulation;
- Hvac\_section\_segment\_termination;
- Hvac\_section\_termination;
- Hvac\_section\_to\_section\_connection;
- Hvac\_section\_to\_section\_termination;
- Hvac\_specification;
- Hvac\_system\_section.

#### **4.1.7. hybrid\_shape\_representation UoF**

The hybrid\_shape UoF specifies the representation of Plant\_item shapes using Brep geometry and topology.

The following application objects are used by the hybrid\_shape UoF:

- B\_rep\_element;
- Conic;
- Curve;
- Free\_form\_curve;
- Line;
- Point;
- Polygon;

- Surface;
- Vector;
- Wire\_and\_surface\_element.

#### **4.1.8.        piping\_component\_characterization UoF**

The piping\_component\_characterization UoF describes the individual elements of the Piping\_system within a Plant. Piping\_component objects include pipes, fittings, valves, in-line equipment, and other elements that regulate, control, or convey Piping\_system fluids.

The following application objects are used by the piping\_component\_characterization UoF:

- Base\_elbow\_support;
- Base\_line\_support;
- Blank;
- Blind\_flange;
- Boss;
- Bushing;
- Cap;
- Compound\_bend\_pipe;
- Coupling;
- Cross;
- Dummy\_leg;
- Eccentric\_base\_elbow\_support;
- Eccentric\_reducer;
- Elbow;
- Expander\_flange;
- Family\_definition;
- Ferrule;
- Fitting;
- Flange;

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- Gasket;
- Gusset;
- Inline\_equipment;
- Inline\_instrument;
- Insert;
- Inside\_and\_thickness;
- Lap\_joint\_flange;
- Lap\_joint\_stub\_end;
- Lateral;
- Lined\_piping;
- Lug;
- Mitre\_bend\_pipe;
- Nipple;
- Olet;
- Orifice\_flange;
- Orifice\_plate;
- Outside\_and\_thickness;
- Paddle\_blank;
- Paddle\_spacer;
- Perforated\_plate;
- Pipe;
- Pipe\_closure;
- Piping\_component;
- Piping\_size\_description;
- Piping\_spool;
- Piping\_support;

- Plate;
- Plug;
- Pressure\_class;
- Reducer;
- Reducing\_flange;
- Reinforcing\_component;
- Reinforcing\_plate;
- Ring\_spacer;
- Schedule;
- Shoe;
- Slip\_on\_flange;
- Slip\_on\_jacket\_flange;
- Socket\_weld\_flange;
- Spacer;
- Specialty\_item;
- Spectacle\_blind;
- Stay;
- Stopper;
- Straight\_pipe;
- Swept\_bend\_pipe;
- Tee;
- Threaded\_flange;
- Union;
- Valve;
- Weld\_neck\_flange;
- Weld\_neck\_jacket\_flange;
- Y\_type\_lateral.

#### **4.1.9.           piping\_inspection UoF**

The piping\_inspection UoF describes inspection information and inspection documentation for Piping\_component objects and Piping\_spool objects.

The following application objects are used by the hvac\_component\_characterization UoF:

- Connection\_inspection\_record;
- Inspection\_condition;
- Piping\_component\_inspection\_record;
- Piping\_spool\_inspection\_record;
- Shape\_inspection\_record.

#### **4.1.10.          piping\_system\_functional\_characterization UoF**

The piping\_system\_functional\_characterization UoF describes the functional connectivity of a Piping\_system and the functional connectivity among Plant\_item objects in that system. This UoF provides the information that describes the functional links and properties of a flow stream in a Piping\_system. It includes information about the segments in the line and the specifications for these segments, such as design criteria, service conditions, and line identifier.

The following application objects are used by the piping\_system\_functional\_characterization UoF:

- Line\_branch\_connection;
- Line\_branch\_termination;
- Line\_piping\_system\_component\_assignment;
- Line\_plant\_item\_branch\_connection;
- Line\_plant\_item\_branch\_connector;
- Line\_plant\_item\_connection;
- Line\_plant\_item\_connector;
- Line\_plant\_item\_termination;
- Line\_to\_line\_connection;
- Line\_to\_line\_termination;
- Piping\_specification;

- Piping\_system\_line;
- Piping\_system\_line\_segment;
- Piping\_system\_line\_segment\_termination;
- Piping\_system\_line\_termination;
- Segment\_insulation;
- Stream\_design\_case;
- Stream\_phase.

#### **4.1.11. plant\_characterization UoF**

The plant\_characterization UoF describes identifiable collections of Plant\_item objects that perform specific functions within a plant. The Plant\_item objects are functionally dependent on one another for the performance of the system and are interrelated through physical connections. The collection of Plant\_system objects as a whole enables the Plant to operate.

The following application objects are used by the plant\_characterization UoF:

- Cableway\_system;
- Ducting\_system;
- Electrical\_system;
- External\_classification;
- Functional\_plant;
- Functional\_plant\_satisfaction;
- Hvac\_system;
- Instrumentation\_and\_control\_system;
- Line\_less\_piping\_system;
- Location\_in\_plant;
- Manufacturing\_line;
- Piping\_system;
- Planned\_physical\_plant;
- Plant;

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- Plant\_process\_capability;
- Plant\_system;
- Plant\_system\_assembly;
- Structural\_system;
- Sub\_plant\_relationship;
- Train;
- Unit.

### **4.1.12. plant\_csg\_shape\_representation UoF**

The plant\_csg\_shape UoF specifies the representation of Plant\_item shapes using CSG primitives.

The following application objects are used by the plant\_csg\_shape UoF:

- Block;
- Circular\_ellipsoid;
- Cone;
- Csg\_element;
- Cylinder;
- Eccentric\_cone;
- Eccentric\_cylinder;
- Eccentric\_pyramid;
- Extrusion;
- Faceted\_brep;
- Hemisphere;
- Pyramid;
- Reducing\_torus;
- Solid\_of\_revolution;
- Sphere;

- Square\_to\_round;
- Torus;
- Trimmed\_block;
- Trimmed\_cone;
- Trimmed\_cylinder;
- Trimmed\_pyramid;
- Trimmed\_sphere;
- Trimmed\_torus.

#### 4.1.13. plant\_item\_characterization UoF

The plant\_item\_characterization UoF describes major elements that Plant objects and Plant\_system objects are comprised of. These are items within a Plant that occupy space and possess physical, measurable characteristics. This UoF specifies spatial and physical information about Piping\_system\_component objects and Equipment, but only spatial characteristics of components of other Plant\_system objects, such as hvac and instrumentation.

This UoF describes the information and options associated with the specification of the substance or substances that a Plant\_item is composed of. It also describes specification and catalogue information concerning piping components.

This UoF describes the spatial shape and position of volumes of space in a Plant.

NOTE 1 Physical plant\_items are things that can be touched.

NOTE 2 As used in this part of ISO 10303, material does not refer to the products that flow within plant systems.

The following application objects are used by the plant\_item\_characterization UoF:

- Analysis\_data\_point;
- Bolt;
- Bolt\_and\_nut\_component;
- Bolt\_and\_nut\_set;
- Cable\_support;
- Catalogue\_definition;
- Catalogue\_item;
- Catalogue\_item\_substitute;

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- Clamp;
- Clamp\_set;
- Connected\_collection;
- Connection\_component;
- Connection\_material;
- Design\_project;
- Document;
- Ducting\_component;
- Electrical\_component;
- Equipment;
- Equipment\_breaching;
- Equipment\_trim\_piping;
- Externally\_defined\_document;
- Externally\_defined\_user\_defined\_attribute\_value;
- Functional\_design\_view;
- Functional\_plant\_item\_satisfaction;
- Hexagon\_head\_bolt;
- Hierarchically\_organized\_collection;
- Hvac\_ducting;
- Installed\_physical\_design\_view;
- Instrument;
- Instrumentation\_and\_control\_component;
- Insulation;
- Material\_specification\_selection;
- Material\_specification\_subset\_reference;
- Nozzle;

- Nut;
- Offline\_instrument;
- Physical\_design\_view;
- Piping\_assembly;
- Piping\_assembly\_assignment;
- Piping\_system\_component;
- Plain\_washer;
- Planned\_physical\_plant\_item;
- Plant\_item;
- Plant\_item\_collection;
- Plant\_item\_definition;
- Plant\_item\_design\_view;
- Plant\_item\_instance;
- Plant\_item\_location;
- Plant\_item\_weight;
- Plant\_volume;
- Process\_ducting;
- Project\_design\_assignment;
- Relative\_item\_location;
- Required\_material\_description;
- Reserved\_space;
- Route;
- Spare\_plant\_item\_usage;
- Spring\_washer;
- Structural\_component;
- Stud\_bolt;
- Supplied\_equipment;

- Supplier;
- Support\_component;
- Support\_constraints;
- Support\_usage;
- Support\_usage\_connection;
- System\_space;
- Toothed\_lock\_washer;
- Trunnion;
- User\_defined\_attribute\_value;
- Washer.

#### **4.1.14.      shape UoF**

The shape UoF specifies the external shapes of components, assemblies of components, and volumes of a Plant. The external shape of a component can be specified as an envelope of the space occupied by a component, as an outline of the component, or as a detailed definition of the shape of a component.

The following application objects are used by the shape UoF:

- Detail\_shape;
- Envelope\_shape;
- Hybrid\_shape\_representation;
- Interfering\_shape\_element;
- Outline\_shape;
- Plant\_csg\_shape\_representation;
- Plant\_item\_centreline;
- Plant\_item\_interference;
- Plant\_item\_interference\_status;
- Plant\_item\_shape;
- Reference\_geometry;

- Shape\_interference\_zone\_usage;
- Shape\_parameter;
- Shape\_representation;
- Shape\_representation\_element;
- Shape\_representation\_element\_usage.

#### **4.1.15. site\_characterization UoF**

The site\_characterization UoF describes the significant features of the Site where the Plant is located. It includes information about the site location, infrastructure like roads and sewers, buildings, and other structures located on the Site, and the shape of the terrain where a Building or Site\_feature is located.

The following application objects are used by the site\_characterization UoF:

- Breakline;
- Building;
- Facet\_trigon;
- Faceted\_surface\_representation;
- Gis\_position;
- Location\_in\_building;
- Location\_in\_site;
- Point\_and\_line\_representation;
- Site;
- Site\_feature;
- Site\_shape\_representation;
- Sited\_plant;
- Survey\_point.

## 4.2. Application objects

This subclause specifies the application objects for the plant spatial configuration application protocol. Each application object is an atomic element that embodies a unique application concept and contains attributes specifying the data elements of the object. The application objects and their definitions are given below.

Each application object attribute need not be present unless the attribute is specifically identified as required for an application object.

### 4.2.1. Analysis\_data\_point

An Analysis\_data\_point is an identifiable point in space that has a relationship to some Plant\_item (see **4.2.260**). Analysis\_data\_point serves as an anchor for contexts external to this part of ISO 10303 allowing information from these external contexts to reference data that is within the scope and format specified in this part of ISO 10303.

The data associated with an Analysis\_data\_point are the following:

- id;
- name;
- location.

#### 4.2.1.1 id

The id specifies a unique identifier for the Analysis\_data\_point.

#### 4.2.1.2 name

The name specifies a textual label given to the Analysis\_data\_point.

#### 4.2.1.3 location

The location specifies the relative position of the Analysis\_data\_point within the Plant (see **4.2.258**). This location need not be within the envelope of the Plant\_item (see **4.2.260**) with which this Analysis\_data\_point is associated.

## 4.2.2. B\_rep\_element

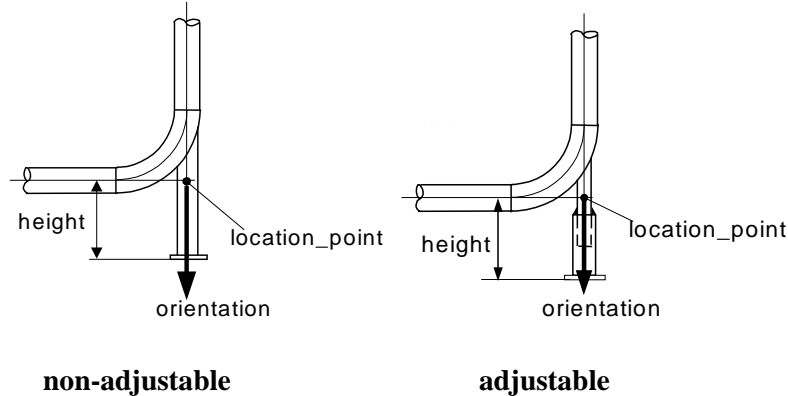
A B\_rep\_element is a type of Shape\_representation\_element (see **4.2.310**) that is composed of geometric and topological elements.

NOTE A B\_rep\_element need not represent a solid shape.

### 4.2.3. Base\_elbow\_support

A **Base\_elbow\_support** is a **Piping\_support** (see 4.2.248) that is attached to a corner of bent part. The main body of the **Base\_elbow\_support** is a pipe with a base plate that is attached at the foot of the main body of the support. The **Base\_elbow\_support** is placed vertically and supports the weight of the piping assembly at the base plate.

NOTE Figure 3 depicts a non-adjustable and an adjustable **Base\_elbow\_support**.



**Figure 3 - Base\_elbow\_support**

The data associated with a **Base\_elbow\_support** are the following:

- height;
- adjustability.

#### 4.2.3.1 height

The height is the distance between the supporting face of the base plate of **Base\_elbow\_support** and the **location\_point**.

#### 4.2.3.2 adjustability

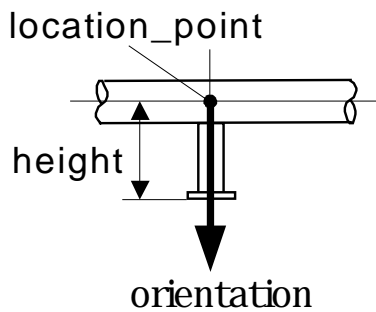
The adjustability specifies a designation that classifies a **Base\_elbow\_support** based on variability of its height. The value of adjustability shall be one of the following:

- adjustable;
- non adjustable.

### 4.2.4. Base\_line\_support

A **Base\_line\_support** is a type of **Piping\_support** (see 4.2.248) that is attached to a horizontal pipe. The main body of the **Base\_line\_support** is usually a pipe, but shape steel or plate is occasionally used as the material of the support. The base plate is attached at the foot of the main body of the **Base\_line\_support**. The **Base\_line\_support** is placed vertically and supports the weight of the piping assembly to which it is attached at the base plate.

NOTE Figure 4 depicts a typical **Base\_line\_support**.



**Figure 4 - Base\_line\_support**

The data associated with a Base\_line\_support are the following:

- height;
- spring.

#### **4.2.4.1 height**

The height specifies the distance between the supporting face of the base plate of the Base\_line\_support and the location\_point.

#### **4.2.4.2 spring**

The spring specifies whether the Base\_line\_support contains a spring. The value of spring is one of the following:

- with\_spring;
- without\_spring.

### **4.2.5. Blank**

A Blank is a type of Fitting (see **4.2.117**) that is placed between two Flange (see **4.2.119**) objects to block the flow of material between the pipelines on either side of the Blank. Each Blank may be one of the following: a Paddle\_blank (see **4.2.230**) or a Spectacle\_blind (see **4.2.325**).

The data associated with a Blank are the following:

- outside\_diameter;
- thickness.

#### 4.2.5.1 outside\_diameter

The `outside_diameter` specifies the external diameter of the Blank. It may be specified as a single value or as a range of values.

NOTE See annex L for a discussion of attributes that may be assigned a single value or a range of values.

#### 4.2.5.2 thickness

The `thickness` specifies the distance between the two faces of the Blank. It may be specified as a single value or as a range of values.

NOTE See annex L for a discussion of attributes that may be assigned a single value or a range of values.

### 4.2.6. Blind\_flange

A `Blind_flange` is a type of `Flange` (see 4.2.119) that is used to block material flow at a flanged connection.

NOTE Figure 5 depicts a typical `Blind_flange`.

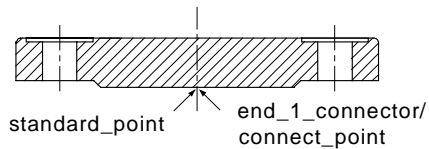


Figure 5 - Blind\_flange

### 4.2.7. Block

A `Block` is a type of `Csg_element` (see 4.2.84) that is a 3D right rectangular solid.

NOTE The size and shape of a `Block` is described by three real values representing the dimensions of the `Block`.

### 4.2.8. Bolt

A `Bolt` is a type of `Bolt_and_nut_component` (see 4.2.9) that is used to fasten two or more `Plant_items` (see 4.2.260) together. The `Bolt` is a rod with a hexagonal, square or round head at one end and a screw thread on the other, or with screw threads on both ends.

The data associated with a `Bolt` are the following:

— bolt\_type.

The bolt\_type specifies a classification of the Bolt based on its shape characteristics.

EXAMPLE Examples of bolt\_type designations include hexagon\_head, and stud.

### **4.2.9. Bolt\_and\_nut\_component**

A Bolt\_and\_nut\_component is a type of Connection\_component (see **4.2.71**) that is a constituent element of a Bolt\_and\_nut\_set (see **4.2.10**). Each Bolt\_and\_nut\_component may be one of the following: a Bolt (see **4.2.8**), a Nut (see **4.2.223**), or a Washer (see **4.2.369**).

The data associated with a Bolt\_and\_nut\_component are the following:

— nominal\_size;

— quantity.

#### **4.2.9.1 nominal\_size**

The nominal\_size specifies a standard size designation of the Bolt\_and\_nut\_component. It may be specified as a single value or as a range of values.

NOTE 1 The nominal size need not represent an actual dimension.

NOTE 2 See annex L for a discussion of attributes that may be assigned a single value or a range of values.

#### **4.2.9.2 quantity**

The quantity specifies the number of Bolt\_and\_nut\_components used in a Bolt\_and\_nut\_set (see **4.2.10**).

### **4.2.10. Bolt\_and\_nut\_set**

A Bolt\_and\_nut\_set is a Connection\_material (see **4.2.74**) that consists of Bolt\_and\_nut\_components (see **4.2.9**) and the Bolt\_and\_nut\_set shall contain at least one Bolt\_and\_nut\_component such as a Bolt (see **4.2.8**), a Nut (see **4.2.223**), or a Washer (see **4.2.369**). The Bolt\_and\_nut\_set is used to connect Piping\_components (see **4.2.240**).

The data associated with a Bolt\_and\_nut\_set are the following:

— set\_id;

— quantity\_used.

#### **4.2.10.1 set\_id**

The set\_id specifies a unique identifier for the Bolt\_and\_nut\_set. The set\_id is required for each Bolt\_and\_nut\_set.

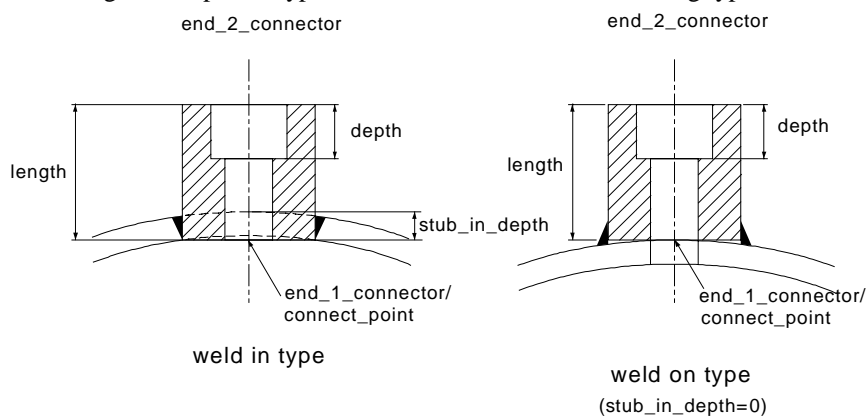
#### **4.2.10.2 quantity\_used**

The `quantity_used` specifies the number of `Bolt_and_nut_sets` used at a `Plant_item_connection` (see 4.2.263).

### 4.2.11. Boss

A Boss is an Olet (see 4.2.225) that is welded onto a pipe perpendicular to the straight run of the pipe. The Boss consists of a counter-bored shape with a Socket (see 4.2.319) on the outside.

NOTE Figure 6 depicts a typical Boss with two different welding types.



**Figure 6 - Boss**

The data associated with a Boss are the following:

— `depth`.

The `depth` specifies the distance from the outer face of the `end_2_connector` to the bottom of the socket. It may be specified as a single value or as a range of values.

NOTE See annex L for a discussion of attributes that may be assigned a single value or a range of values.

### 4.2.12. Branch\_hole

A `Branch_hole` is a type of `Piping_connector` (see 4.2.242) end type that is a hole cut in a pipe for a branch connection.

NOTE A `Branch_hole` is not typically a design feature of the pipe, but rather is added after the fact to create a branch from the pipe. The hole may be used for stub-in connections, olets, or nipples can be welded or screwed to it.

The data associated with a `Branch_hole` are the following:

— `diameter`;

— `stub_in_depth`.

#### 4.2.12.1 diameter

The `diameter` specifies the diameter value of the `Branch_hole`. It may be specified as a single value or as a range of values.

NOTE See annex L for a discussion of attributes that may be assigned a single value or a range of values.

#### 4.2.12.2 stub\_in\_depth

The stub\_in\_depth specifies the distance from the end of a stubbed-in Piping\_component (see 4.2.240) to the point where the centreline of the stubbed-in Piping\_component intersects the outer surface of the other Piping\_component. It may be specified as a single value or as a range of values.

NOTE 1 See annex L for a discussion of attributes that may be assigned a single value or a range of values.

NOTE 2 The attribute for stub\_in\_depth will only be used when the Piping\_component (see 4.2.240) participates in a connection.

### 4.2.13. Breakline

A Breakline is a contiguous set of straight line segments that designate a path across a Site\_shape\_representation (see 4.2.315).

NOTE The path is a constraint on the mathematical interpolation of the surface of the terrain.

### 4.2.14. Building

A Building is a partially or totally enclosed structure located on a Site (see 4.2.313) that contains Plant\_system (see 4.2.276) objects or provides supporting infrastructure within its boundaries. The z-axis of the local coordinate system of the Building shall be considered the elevation of the coordinate space.

The data associated with a Building are the following:

- building\_id;
- location\_and\_orientation;
- name;
- shape.

#### 4.2.14.1 building\_id

The building\_id specifies a unique number used to identify the building. Building\_id is required for each Building.

#### 4.2.14.2 location\_and\_orientation

The location\_and\_orientation specifies the position of the Building relative to the site coordinate system and the orientation of the Building relative to a specified direction.

EXAMPLE E5704.35', N5912.87' are coordinates. They can be used to locate a known point in the Building (e.g., centrelines of column row 1A).

#### 4.2.14.3 name

The name specifies a textual label given to the Building.

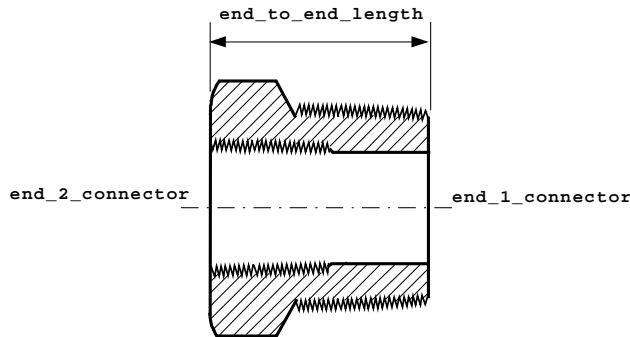
#### 4.2.14.4 shape

The shape specifies the outline or characteristic surface configuration or contour of the building.

### 4.2.15. Bushing

A Bushing is a type of Fitting (see 4.2.117) with one external and one smaller internal end.

NOTE Figure 7 depicts a typical threaded hexagon Bushing. It is typically used to connect a smaller Pipe (see 4.2.236) to a larger Fitting or Nozzle.



**Figure 7 - Bushing**

The data associated with a Bushing are the following:

- end\_1\_connector;
- end\_2\_connector;
- end\_to\_end\_length.

#### 4.2.15.1 end\_1\_connector

The end\_1\_connector specifies the Piping\_connector (see 4.2.242) Male\_end (see 4.2.215).

#### 4.2.15.2 end\_2\_connector

The end\_2\_connector specifies the Piping\_connector (see 4.2.242) Female\_end (see 4.2.116).

#### 4.2.15.3 end\_to\_end\_length

The end\_to\_end\_length specifies the external length of the Bushing from the end-one face to the end-two face. It may be specified as a single value or as a range of values.

NOTE See annex L for a discussion of attributes that may be assigned a single value or a range of values.

#### 4.2.16. Butt weld

A Butt weld is a type of Piping\_connector (see 4.2.242) that consists of the welding of two Piping\_component (see 4.2.240) objects where they are aligned edge to edge.

The data associated with a Butt weld are the following:

— root\_gap.

The root\_gap specifies the distance between the end faces of two Piping\_components (see 4.2.240) that are butewlded. It may be specified as a single value or as a range of values.

NOTE 1 See annex L for a discussion of attributes that may be assigned a single value or a range of values.

NOTE 2 The attribute for root\_gap will only be used when the Piping\_component (see 4.2.240) participates in a connection.

#### 4.2.17. Cable

A Cable is a group of one or more electrical conductors bound together to follow the same path through space, and insulated from each other.

EXAMPLE Multi-conductor power cables, bus bars, twisted-pair ethernet cables, fiber-optic cables, telephone cables, hook-up wire.

#### 4.2.18. Cable\_support

A Cable\_support is a type of Support\_component (see 4.2.343) that provides support to Electrical\_component (see 4.2.99) objects.

The data associated with a Cable\_support are the following:

— cable\_support\_type.

The cable\_support\_type specifies a description of the category of Cable\_support.

#### 4.2.19. Cableway\_component

A Cableway\_component is a type of Plant\_item (see 4.2.260) that is a part of a Cableway\_system (see 4.2.24). Each Cableway\_component may be a Cableway\_piece (see 4.2.22), a Cableway\_fitting (see 4.2.21), or a Raceway\_lane (see 4.2.290).

#### 4.2.20. Cableway\_connector

A Cableway\_connector is a type of Plant\_item\_connector (see **4.2.265**) that establishes a link between two Cableway\_component (see **4.2.19**) objects.

The data associated with a Cableway\_connector are the following:

— type.

The type specifies the kind of Cableway\_connector.

#### **4.2.21. Cableway\_fitting**

A Cableway\_fitting is a type of Cableway\_component (see **4.2.19**) that joins or fits two other Cableway\_components (see **4.2.19**) together.

#### **4.2.22. Cableway\_piece**

A Cableway\_piece is a type of Cableway\_component (see **4.2.19**) that has one or more channels through which Cable (see **4.2.17**) objects may be run. Each Cableway\_piece is either a Raceway (see **4.2.289**) or a Conduit (see **4.2.66**).

#### **4.2.23. Cableway\_size\_description**

A Cableway\_size\_description is used to explain or summarize the physical size of a Cableway\_component (see **4.2.19**) or Cableway\_connector (see **4.2.20**), based on a set of dimensional characteristics. Each Cableway\_size\_description is either a Raceway\_size\_description (see **4.2.291**) or a Conduit\_size\_description (see **4.2.67**).

The data associated with a Cableway\_size\_description are the following:

— fill\_area.

The fill\_area specifies the cross-sectional area of the usable portion of the cavity within a Cableway\_component (see **4.2.19**) that is available to be filled with Cable (see **4.2.17**) objects.

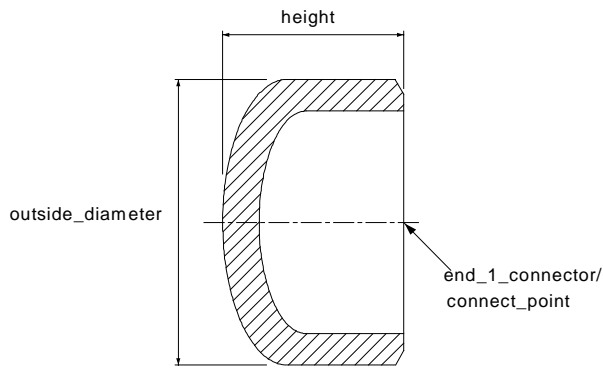
#### **4.2.24. Cableway\_system**

A Cableway\_system is a type of Plant\_system (see **4.2.276**) that is a system of interconnected Cableway\_component (see **4.2.19**) objects form a series of channels to hold Cable (see **4.2.17**) objects.

#### **4.2.25. Cap**

A Cap is a type of Pipe\_closure (see **4.2.237**) which closes the end of the pipe.

NOTE Figure 8 depicts a typical welded round Cap.



**Figure 8 - Cap**

The data associated with a Cap are the following:

— height.

The height is the distance between the end and the top of the Cap.

#### **4.2.26. Catalogue\_connector**

A Catalogue\_connector is the definition or the reference of a Connector\_definition (see 4.2.75). A Connector\_definition may appear in a catalogue, or the properties of a Connector\_definition may be drawn from a catalogue.

NOTE A Catalogue\_connector is analogous to a Catalogue\_item (see 4.2.28) in that both have standardized characteristics.

#### **4.2.27. Catalogue\_definition**

A Catalogue\_definition is the identification of a document that lists Catalogue\_item (see 4.2.28) objects.

NOTE 1 Catalogue\_definition may reference either an electronic or printed catalogue.

NOTE 2 A Catalogue\_definition may be defined by ISO 13584 [13]. ISO 13584 will be considered a normative reference when it has reached the DIS level.

The data associated with a Catalogue\_definition are the following:

— catalogue\_id;

— catalogue\_name;

— catalogue\_version.

##### **4.2.27.1 catalogue\_id**

The catalogue\_id specifies a unique identifier given to a catalogue. Catalogue\_id is required for each Catalogue\_definition.

**4.2.27.2 catalogue\_name**

The catalogue\_name specifies a textual label given to the catalogue.

**4.2.27.3 catalogue\_version**

The catalogue\_version specifies a particular release of a catalogue within a sequence of catalogue releases.

**4.2.28. Catalogue\_item**

A Catalogue\_item is an item whose characteristics are standardized and have been categorized in a library or catalogue. A Catalogue\_item that is defined by a Plant\_item\_definition (see **4.2.267**) must be defined by a Plant\_item\_definition in which the Plant\_item (see **4.2.260**) is defined as a Physical\_design\_view (see **4.2.235**).

The data associated with a Catalogue\_item are the following:

- item\_name;
- item\_version;
- model\_number.

**4.2.28.1 item\_name**

The item\_name specifies a textual label that is used by the supplier to refer to the Catalogue\_item.

**4.2.28.2 item\_version**

The item\_version specifies a particular release of a Catalogue\_item within a sequence of Catalogue\_item releases.

NOTE This attribute accommodates the possibility of revision pages to a supplier catalogue.

**4.2.28.3 model\_number**

The model\_number is the identifier assigned by the supplier to one or more Catalogue\_item objects.

**4.2.29. Catalogue\_item\_substitute**

A Catalogue\_item\_substitute is an alternate Catalogue\_item (see **4.2.28**) that can be used instead of the specified Catalogue\_item.

**4.2.30. Change**

A Change is the modification or requested modification of a Plant\_item (see **4.2.260**).

NOTE A Change may be a request to make a change or an approved change.

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The data associated with a Change are the following:

- business\_unit;
- change\_id;
- change\_reason;
- change\_summary;
- date;
- project\_number;
- revision;
- title.

### 4.2.30.1 business\_unit

The business\_unit specifies the organization(s), company(s), or functional group(s) responsible for the Change.

### 4.2.30.2 change\_id

The change\_id specifies a unique identifier for the Change.

### 4.2.30.3 change\_reason

The change\_reason specifies the rationale for the Change.

### 4.2.30.4 change\_summary

The change\_summary specifies a general description of the Change.

### 4.2.30.5 date

The date specifies the calendar day-month-year and time that the Change was initiated on.

NOTE A specific ordering of the day, month, and year within the date is not required.

### 4.2.30.6 project\_number

The project\_number specifies a designation assigned to identify projects within an organization. More than one project (and therefore more than one project\_number) may be associated with a Change.

EXAMPLE Identification of a project\_number is used to allow tracking of items such as costs and job hours associated with a Change.

NOTE A project\_number may or may not be the same as the designation of a Design\_project (see 4.2.87).

**4.2.30.7 revision**

The revision specifies the particular amendment of the Change within a sequence of amendments.

**4.2.30.8 title**

The title specifies a descriptive label for the Change.

**4.2.31. Change\_approval**

A Change\_approval is the endorsement by an authority of the change in status of a specific Change (see 4.2.30).

The data associated with a Change\_approval are the following:

— approval\_date;

— approver;

— approver\_role.

**4.2.31.1 approval\_date**

The approval\_date specifies the specific calendar day-month-year and time when the approval authority signed the Change as approved.

NOTE A specific ordering of the day, month, and year within the date is not required.

**4.2.31.2 approver**

The approver specifies the name of the individual who endorsed the Change.

**4.2.31.3 approver\_role**

The approver\_role specifies the purpose or function of the approver that approves a change.

**4.2.32. Change\_item**

A Change\_item is an item that may be modified, for which there is a request to modify, or is the result of a modification to a Change\_item. Each Change\_item is either: a Changed\_line\_assignment (see 4.2.36), a Changed\_line\_branch\_connection (see 4.2.37), a Changed\_line\_plant\_item\_branch\_connection (see 4.2.38), a Changed\_line\_plant\_item\_connection (see 4.2.39), a Changed\_line\_to\_line\_connection (see 4.2.40), a Changed\_piping\_system\_line (see 4.2.42), a Changed\_piping\_system\_line\_segment (see 4.2.43), a Changed\_piping\_system\_line\_segment\_termination (see 4.2.44), a Changed\_planned\_physical\_plant (see 4.2.45), a Changed\_plant (see 4.2.46), a Changed\_plant\_item (see 4.2.47), a Changed\_plant\_item\_collection (see 4.2.48), a Changed\_plant\_item\_connection (see 4.2.49), a Changed\_plant\_item\_connector (see 4.2.50), a Changed\_plant\_item\_shape (see 4.2.52), a Changed\_plant\_process\_capability (see 4.2.53), a Changed\_plant\_system (see 4.2.54), a Changed\_reference\_geometry (see 4.2.55), a Changed\_required\_material\_description (see 4.2.56), a Changed\_sited\_plant (see 4.2.59), or a Changed\_sub\_plant\_relationship (see 4.2.60).

The data associated with a Change\_item are the following:

- creation\_date;
- description;
- from\_or\_to;
- item\_owner;
- supersedence\_status.

#### **4.2.32.1 creation\_date**

The creation\_date specifies the calendar day-month-year and time that the Change\_item is created on.

NOTE A specific ordering of the day, month, and year within the date is not required.

#### **4.2.32.2 description**

The description specifies a textual explanation or summary of the item being changed.

#### **4.2.32.3 from\_or\_to**

The from\_or\_to specifies whether the Change\_item object is to be interpreted as the successor or predecessor in a change. The from\_or\_to shall have one of the following values:

- from;
- to.

##### **4.2.32.3.1 from**

from specifies that the Change\_item is the predecessor in a change relationship.

##### **4.2.32.3.2 to**

to specifies that the Change\_item is the successor in a change relationship.

#### **4.2.32.4 item\_owner**

The item\_owner specifies the name of the person or organization that owns the item being changed and is responsible for implementing or approving the change.

#### **4.2.32.5 supersedence\_status**

The status specifies the textual description of the existence condition of a Change\_item.

EXAMPLE Examples of Change\_item status include Current, Superseded, and Deleted.

### 4.2.33. **Change\_life\_cycle\_stage**

A `Change_life_cycle_stage` is a state in the life cycle of the change that indicates or classifies the status or disposition of the change.

The data associated with a `Change_life_cycle_stage` are the following:

— `name`.

The `name` specifies a textual label given to the stage.

EXAMPLE Examples of names include requested, pending, and implemented.

### 4.2.34. **Change\_life\_cycle\_stage\_sequence**

A `Change_life_cycle_stage_sequence` is the mechanism that specifies the sequence of life-cycle stages.

### 4.2.35. **Change\_life\_cycle\_stage\_usage**

A `Change_life_cycle_stage_usage` is the assignment of a `Change` (see 4.2.30) to a particular `Change_life_cycle_stage` (see 4.2.33).

The data associated with a `Change_life_cycle_stage_usage` are the following:

— `date_of_activation`;

— `date_of_completion`;

— `description`.

#### 4.2.35.1 **date\_of\_activation**

The `date_of_activation` specifies the calendar day-month-year and time when the `Change` was assigned to the `Change_life_cycle_stage`. A specific ordering of the day, month, and year within the date is not required.

#### 4.2.35.2 **date\_of\_completion**

The `date_of_completion` specifies the calendar day-month-year and time when the `Change` was released from, or completed, the assigned `life_cycle stage`.

#### 4.2.35.3 **description**

The `description` specifies a textual explanation or summary of the assignment of the `Change` to a particular stage.

### 4.2.36. **Changed\_line\_assignment**

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A **Changed\_line\_assignment** is a type of **Change\_item** (see **4.2.32**) that identifies a **Line\_piping\_system\_component\_assignment** (see **4.2.200**) that is being changed or is the result of a **Change** (see **4.2.30**).

### **4.2.37. Changed\_line\_branch\_connection**

A **Changed\_line\_branch\_connection** is a type of **Change\_item** (see **4.2.32**) that identifies a **Line\_branch\_connection** (see **4.2.197**) that is being changed or is the result of a **Change** (see **4.2.30**).

### **4.2.38. Changed\_line\_plant\_item\_branch\_connection**

A **Changed\_line\_plant\_item\_branch\_connection** is a type of **Change\_item** (see **4.2.32**) that identifies a **Line\_plant\_item\_branch\_connection** (see **4.2.201**) that is being changed or is the result of a **Change** (see **4.2.30**).

### **4.2.39. Changed\_line\_plant\_item\_connection**

A **Changed\_line\_plant\_item\_connection** is a type of **Change\_item** (see **4.2.32**) that identifies a **Line\_plant\_item\_connection** (see **4.2.203**) that is being changed or is the result of a **Change** (see **4.2.30**).

### **4.2.40. Changed\_line\_to\_line\_connection**

A **Changed\_line\_to\_line\_connection** is a type of **Change\_item** (see **4.2.32**) that identifies a **Line\_to\_line\_connection** (see **4.2.206**) that is being changed or is the result of a **Change** (see **4.2.30**).

### **4.2.41. Changed\_piping\_specification**

A **Changed\_piping\_specification** is a type of **Change\_item** (see **4.2.32**) that identifies a **Piping\_specification** (see **4.2.245**) that is being changed or is the result of a **Change** (see **4.2.30**).

### **4.2.42. Changed\_piping\_system\_line**

A **Changed\_piping\_system\_line** is a type of **Change\_item** (see **4.2.32**) that identifies a **Piping\_system\_line** (see **4.2.251**) that is being changed or is the result of a **Change** (see **4.2.30**).

### **4.2.43. Changed\_piping\_system\_line\_segment**

A **Changed\_piping\_system\_line\_segment** is a type of **Change\_item** (see **4.2.32**) that identifies a **Piping\_system\_line\_segment** (see **4.2.252**) that is being changed or is the result of a **Change** (see **4.2.30**).

### **4.2.44. Changed\_piping\_system\_line\_segment\_termination**

A `Changed_piping_system_line_segment_termination` is a type of `Change_item` (see 4.2.32) that identifies a `Piping_system_line_segment_termination` (see 4.2.253) that is being changed or is the result of a `Change` (see 4.2.30).

#### **4.2.45.      `Changed_planned_physical_plant`**

A `Changed_planned_physical_plant` is a type of `Change_item` (see 4.2.32) that identifies a `Planned_physical_plant` (see 4.2.256) that is being changed or is the result of a `Change` (see 4.2.30).

#### **4.2.46.      `Changed_plant`**

A `Changed_plant` is a type of `Change_item` (see 4.2.32) that identifies a `Plant` (see 4.2.258) that is being changed or is the result of a `Change` (see 4.2.30).

#### **4.2.47.      `Changed_plant_item`**

A `Changed_plant_item` is a type of `Change_item` (see 4.2.32) that identifies a `Plant_item` (see 4.2.260) that is being changed or is the result of a `Change` (see 4.2.30).

#### **4.2.48.      `Changed_plant_item_collection`**

A `Changed_plant_item_collection` is a type of `Change_item` (see 4.2.32) that identifies a `Plant_item_collection` (see 4.2.262) that is being changed or is the result of a `Change` (see 4.2.30).

#### **4.2.49.      `Changed_plant_item_connection`**

A `Changed_plant_item_connection` is a type of `Change_item` (see 4.2.32) that identifies a `Plant_item_connection` (see 4.2.263) that is being changed or is the result of a `Change` (see 4.2.30).

#### **4.2.50.      `Changed_plant_item_connector`**

A `Changed_plant_item_connector` is a type of `Change_item` (see 4.2.32) that identifies a `Plant_item_connector` (see 4.2.265) that is being changed or is the result of a `Change` (see 4.2.30).

#### **4.2.51.      `Changed_plant_item_location`**

A `Changed_plant_item_location` is a type of `Change_item` (see 4.2.32) that identifies a `Plant_item_location` (see 4.2.272) that is being changed or is the result of a `Change` (see 4.2.30).

#### **4.2.52.      `Changed_plant_item_shape`**

A `Changed_plant_item_shape` is a type of `Change_item` (see 4.2.32) that identifies a `Plant_item_shape` (see 4.2.273) that is being changed or is the result of a `Change` (see 4.2.30).

#### **4.2.53.      `Changed_plant_process_capability`**

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A **Changed\_plant\_process\_capability** is a type of **Change\_item** (see **4.2.32**) that identifies a **Plant\_process\_capability** (see **4.2.275**) that is being changed or is the result of a **Change** (see **4.2.30**).

### **4.2.54. Changed\_plant\_system**

A **Changed\_plant\_system** is a type of **Change\_item** (see **4.2.32**) that identifies a **Plant\_system** (see **4.2.276**) that is being changed or is the result of a **Change** (see **4.2.30**).

### **4.2.55. Changed\_reference\_geometry**

A **Changed\_reference\_geometry** is a type of **Change\_item** (see **4.2.32**) that identifies a **Reference\_geometry** (see **4.2.295**) that is being changed or is the result of a **Change** (see **4.2.30**).

### **4.2.56. Changed\_required\_material\_description**

A **Changed\_required\_material\_description** is a type of **Change\_item** (see **4.2.32**) that identifies a **Required\_material\_description** (see **4.2.299**) that is being changed or is the result of a **Change** (see **4.2.30**).

### **4.2.57. Changed\_site**

A **Changed\_site** is a type of **Change\_item** (see **4.2.32**) that identifies a **Site** (see **4.2.313**) that is being changed or is the result of a **Change** (see **4.2.30**).

### **4.2.58. Changed\_site\_feature**

A **Changed\_site\_feature** is a type of **Change\_item** (see **4.2.32**) that identifies a **Site\_feature** (see **4.2.314**) that is being changed or is the result of a **Change** (see **4.2.30**).

### **4.2.59. Changed\_sited\_plant**

A **Changed\_sited\_plant** is a type of **Change\_item** (see **4.2.32**) that identifies a **Sited\_plant** (see **4.2.316**) that is being changed or is the result of a **Change** (see **4.2.30**).

### **4.2.60. Changed\_sub\_plant\_relationship**

A **Changed\_sub\_plant\_relationship** is a type of **Change\_item** (see **4.2.32**) that identifies a **Sub\_plant\_relationship** (see **4.2.340**) that is being changed or is the result of a **Change** (see **4.2.30**).

### **4.2.61. Circular\_ellipsoid**

A **Circular\_ellipsoid** is a type of **Csg\_element** (see **4.2.84**) that has the following geometric characteristics: it is axial symmetric; cross sections taken in a plane normal to the axis result are circular; cross sections taken in plane containing the axis are elliptical; it is trimmed with a plane that is normal to an axis.

NOTE The shape of a Circular\_ellipsoid may be described as a hemisphere that has been compressed along the circular axis.

#### 4.2.62. Clamp

A Clamp is a set of devices used to join, grip, support, or compress mechanical or structural parts with opposing, often adjustable sides or parts for use in suspending pipe or for fastening hose to an end of pipe or fitting.

NOTE Figure 9 depicts a typical Pipe Clamp.

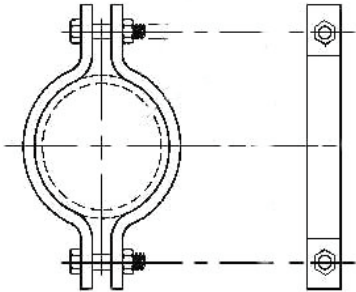


Figure 9 - Pipe Clamp

#### 4.2.63. Clamped

A Clamped is a type of Piping\_connector (see 4.2.242) that is a physical feature of a Plant\_item (see 4.2.260) at which a Pipe Clamp (see 4.2.62) is attached.

#### 4.2.64. Clamp\_set

A Clamp\_set is the collection of fasteners and items to be fully used with a Clamp (see 4.2.62).

The data associated with a Clamp\_set are the following:

- set\_id;
- quantity.

##### 4.2.64.1 set\_id

The set\_id specifies a unique identifier for the Clamp\_set. The set\_id is required for each Clamp\_set.

##### 4.2.64.2 quantity

The quantity is the number of items in the Clamp\_set.

## 4.2.65. Compound\_bend\_pipe

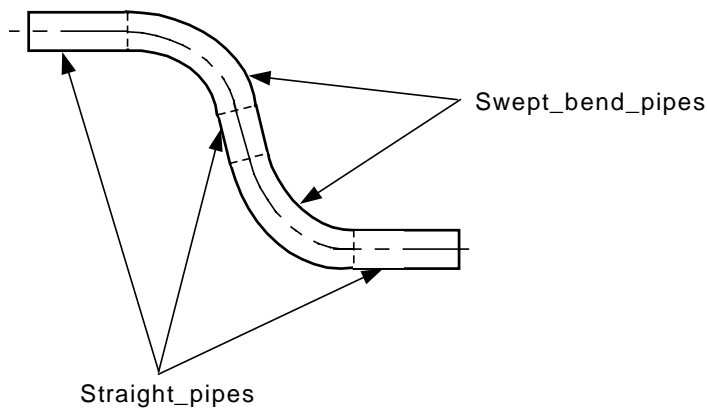
A Compound\_bend\_pipe is a type of Pipe (see 4.2.236) that is comprised of one or more of the following items grouped together and treated as a single Piping\_component (see 4.2.240).

- Straight\_pipe (see 4.2.332)
- Swept\_bend\_pipe (see 4.2.349)
- Mitre\_bend\_pipe (see 4.2.219)

The Compound\_bend\_pipe shall include at least one Swept\_bend\_pipe or Mitre\_bend\_pipe.

The relationship between the Compound\_bend\_pipe and its constituents shall be established using Connected\_collection (see 4.2.70).

NOTE Figure 10 depicts a typical Compound\_bend\_pipe.



**Figure 10 - Compound\_bend\_pipe**

## 4.2.66. Conduit

A Conduit is a type of Cableway\_piece (see 4.2.22) that is a tube with a round cross section that holds Cable (see 4.2.17) objects.

EXAMPLE Liquid-tight conduit, flexible conduit, rigid steel conduit, intermediate steel conduit, electrical metallic tubing, power concrete encased duct bank use conduit, rigid heavy wall conduit, rigid extra-heavy wall conduit.

## 4.2.67. Conduit\_size\_description

A Conduit\_size\_description is a type of Cableway\_size\_description (see 4.2.23) that is used to explain or summarize the physical size of a Conduit (see 4.2.66) based on a set of dimensional characteristics.

The data associated with a Conduit\_size\_description are the following:

- outer\_diameter;
- inner\_diameter;
- thickness.

**4.2.67.1 outer\_diameter**

The `outer_diameter` specifies the external diameter of the Conduit (see **4.2.66**). It may be specified as a single value or as a range of values.

NOTE See annex L for a discussion of attributes that may be assigned a single value or a range of values.

**4.2.67.2 inner\_diameter**

The `inner_diameter` specifies the diameter of the opening of the Conduit (see **4.2.66**). It may be specified as a single value or as a range of values.

NOTE See annex L for a discussion of attributes that may be assigned a single value or a range of values.

**4.2.67.3 thickness**

The `thickness` specifies the width of the wall of the Conduit (see **4.2.66**). It may be specified as a single value or as a range of values.

NOTE See annex L for a discussion of attributes that may be assigned a single value or a range of values.

**4.2.68. Cone**

A Cone is a type of `Csg_element` (see **4.2.84**) that is a 3D volume with parallel, coaxial, circular cross-sections of radii that varies uniformly from a circular base to an axis normal to and positioned at the centre point of the base.

**4.2.69. Conic**

A Conic is a type of `Curve` (see **4.2.85**) composed of points located at a uniform distance from a point, a pair of points, or a point and a line.

EXAMPLE Kinds of Conics include circles, ellipses, parabolas, and hyperbolas.

**4.2.70. Connected\_collection**

A `Connected_collection` is a type of `Plant_item_collection` (see **4.2.262**) where elements of the whole collection must be connected.

NOTE These connections may be identified explicitly by `Plant_item_connection` (see **4.2.263**) objects.

EXAMPLE A set of `Plant_item` (see **4.2.260**) objects can be collected for the purpose of defining the items that comprise an assembly. Examples of this assembly include packaged unit and module in a plant.

**4.2.71. Connection\_component**

A `Connection_component` is a `Plant_item` (see **4.2.260**) that is used for the purpose of connecting other `Plant_items`.

**4.2.72. Connection\_definition**

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A `Connection_definition` is a type of `Plant_item_connection` (see **4.2.263**) that specifies connection comprised of two or more connectors that is part of a `Plant_item_definition` (see **4.2.267**).

NOTE A `Connection_definition` that is part of a `Plant_item_definition` (see **4.2.267**) implies that the `Plant_item_definition` is a `Connected_collection` (see **4.2.70**).

### 4.2.73. Connection\_inspection\_record

A `Connection_inspection_record` is a collection of information that captures the result of an evaluation of an observed value for a characteristic of a connection against an expected or prescribed value for that characteristic, as well as information to evaluate the acceptability of the observed value.

The data associated with a `Connection_inspection_record` are the following:

- `inspected_property_name`;
- `connection_type`;
- `inspection_type`;
- `weld_id`;
- `connecting_portion_id`;
- `inspected_property_tolerance`;
- `inspected_property_measured_value`.

#### 4.2.73.1 inspected\_property\_name

The `inspected_property_name` specifies the characteristic for which information is being recorded. The `inspected_property_name` may be one of the following:

For welded connections:

- `fit up`;
- `drift diameter tolerance`;
- `welding procedure`;
- `weld dimension`;
- `welding person`;
- `nde`;
- `heat treatment`;
- `hardness test`;

For flanged connections:

- `fit up`;
- `gasket type`;

- gasket thickness ;
- gasket compressed thickness;
- bolt and nut tightening torque.

For threaded connections:

- fit up;
- gasket type;
- gasket thickness;
- gasket compressed thickness;
- threaded tightening torque.

#### **4.2.73.2 connection\_type**

The `connection_type` specifies the kind of connection that is being inspected. The `connection_type` may be one of the following:

- buttweld;
- slip on;
- socket;
- stub in;
- threaded;
- flanged.

#### **4.2.73.3 inspection\_type**

The `inspection_type` specifies the kind of inspection that is being performed. The `inspection_type` may be one of the following:

- pt;
- mt;
- ut;
- rt;
- visual examination.

#### **4.2.73.4 weld\_id**

The `weld_id` is an identification of the weld point at which the inspection is being made.

#### **4.2.73.5 connecting\_portion\_id**

The `connecting_portion_id` specifies a descriptive identification of the area of the connection that is being inspected.

EXAMPLE For a welded slip on flange connection, two connecting portions may be defined – the inner portion where the end of the pipe is welded to the inner surface of the fitting, and the outside portion where the end of the fitting is welded to the outside of the pipe.

#### **4.2.73.6 inspected\_property\_tolerance**

The `inspected_property_tolerance` specifies the acceptable deviation for the measured result of the inspection.

The inspected\_property\_measured\_value specifies the recorded result of the inspection.

#### 4.2.74. Connection\_material

The Connection\_material specifies the substances or other Plant\_item (see 4.2.260) objects used at the connection of two Plant\_item\_connector (see 4.2.265) objects. This may be one or more specifications and one or more Plant\_item objects.

EXAMPLE At a connection of two butt-weld connectors, there is a welding specification that applies to the connection. At a connection of two flanged connectors there are bolts and nuts that connect the Flanges (see 4.2.119), as well as a specification for the use of these items.

The data associated with a Connection\_material are the following:

— material\_name.

The material\_name specifies common nomenclature used to refer to the material.

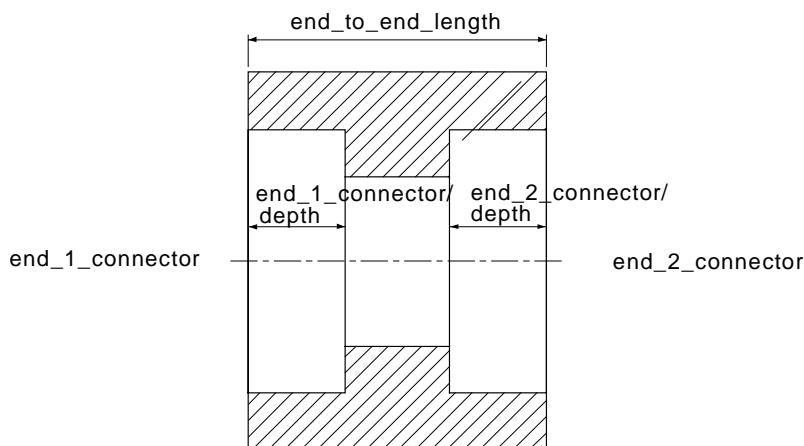
#### 4.2.75. Connector\_definition

A Connector\_definition is a type of Plant\_item\_connector (see 4.2.265) that identifies the connector where a non-instantiated Plant\_item (see 4.2.260) can connect to one or more other Plant\_item\_connector objects.

#### 4.2.76. Coupling

A Coupling is a type of Fitting (see 4.2.117) that is used to make a linear connection between two pipes.

NOTE Figure 11 depicts a typical socket-weld Coupling.



**Figure 11- Socket weld Coupling**

The data associated with a Coupling are the following:

- end\_1\_connector;
- end\_2\_connector;
- end\_to\_end\_length.

#### 4.2.76.1 end\_1\_connector

The end\_1\_connector specifies the Piping\_connector (see 4.2.242) designated as end one.

#### 4.2.76.2 end\_2\_connector

The end\_2\_connector specifies the Piping\_connector (see 4.2.242) designated as end two.

#### 4.2.76.3 end\_to\_end\_length

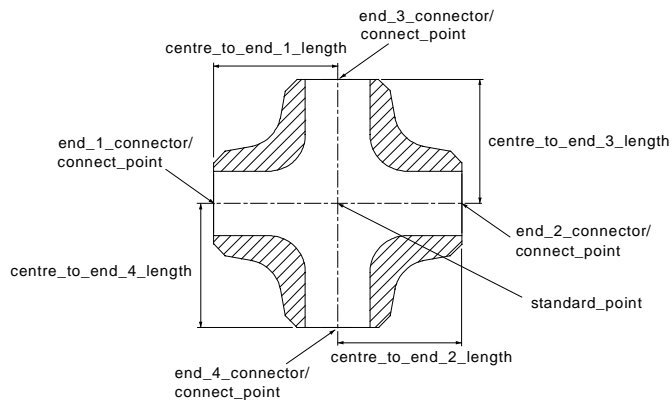
The end\_to\_end\_length specifies the external distance between the end-one and end-two faces. It may be specified as a single value or as a range of values.

NOTE See annex L for a discussion of attributes that may be assigned a single value or a range of values.

### 4.2.77. Cross

A Cross is a type of Fitting (see 4.2.117) that is a branched outlet consisting of four perpendicular legs to provide straight through and 90 degree flow.

NOTE Figure 12 depicts a typical butt-weld Cross.



**Figure 12 - Butt-weld Cross**

The data associated with a Cross are the following:

- centre\_to\_end\_1\_length;
- centre\_to\_end\_2\_length;
- centre\_to\_end\_3\_length;
- centre\_to\_end\_4\_length;
- end\_1\_connector;

— end\_2\_connector;

— end\_3\_connector;

— end\_4\_connector.

#### **4.2.77.1 centre\_to\_end\_1\_length**

The `centre_to_end_1_length` specifies the distance from the intersection of the cross straight-run centreline and branch-run centreline to the end-one (straight-run) face. It may be specified as a single value or as a range of values.

NOTE See annex L for a discussion of attributes that may be assigned a single value or a range of values.

#### **4.2.77.2 centre\_to\_end\_2\_length**

The `centre_to_end_2_length` specifies the distance from the intersection of the cross straight-run centreline and branch-run centreline to the end-two (straight-run) face. It may be specified as a single value or as a range of values.

NOTE See annex L for a discussion of attributes that may be assigned a single value or a range of values.

#### **4.2.77.3 centre\_to\_end\_3\_length**

The `centre_to_end_3_length` specifies the distance from the intersection of the cross straight-run centreline and branch-run centreline to the end-three (branch-run) face. It may be specified as a single value or as a range of values.

NOTE See annex L for a discussion of attributes that may be assigned a single value or a range of values.

#### **4.2.77.4 centre\_to\_end\_4\_length**

The `centre_to_end_4_length` specifies the distance from the intersection of the cross straight-run centreline and branch-run centreline to the end-four (branch-run) face. It may be specified as a single value or as a range of values.

NOTE See annex L for a discussion of attributes that may be assigned a single value or a range of values.

#### **4.2.77.5 end\_1\_connector**

The `end_1_connector` specifies the `Piping_connector` (see **4.2.242**) designated as end one.

#### **4.2.77.6 end\_2\_connector**

The `end_2_connector` specifies the `Piping_connector` (see **4.2.242**) designated as end two.

#### **4.2.77.7 end\_3\_connector**

The `end_3_connector` specifies the `Piping_connector` (see **4.2.242**) designated as end three.

#### **4.2.77.8 end\_4\_connector**

The end\_4\_connector specifies the Piping\_connector (see 4.2.242) designated as end four.

#### 4.2.78. Cross\_section\_flat\_oval

A Cross\_section\_flat\_oval is a type of Hvac\_cross\_section (see 4.2.150).

NOTE Figure 13 depicts a typical Cross\_section\_flat\_oval.

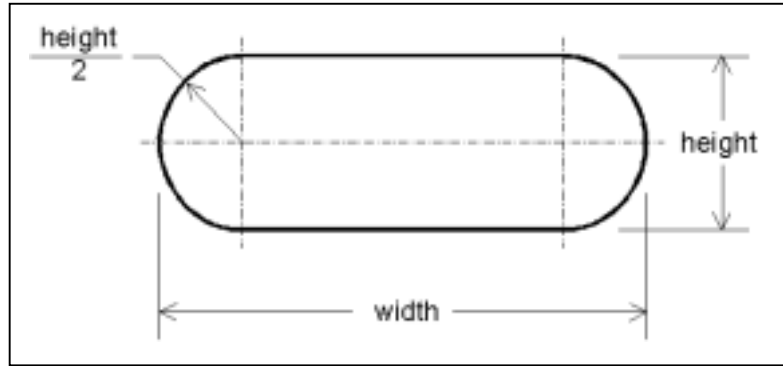


Figure 13 - Cross\_section\_flat\_oval

The data associated with a Cross\_section\_flat\_oval are the following:

- height;
- width.

##### 4.2.78.1 height

This attribute specifies the distance between the flats as shown in Figure 13.

##### 4.2.78.2 width

This attribute specifies the distance between the outside of the rounds as shown in Figure 13.

#### 4.2.79. Cross\_section\_non\_standard

The Cross\_section\_non\_standard is a type of Hvac\_cross\_section (see 4.2.150) which cannot be defined by a set of common parameters and therefore requires explicit geometry to define the shape of the cross section.

The data associated with a Cross\_section\_non\_standard are the following:

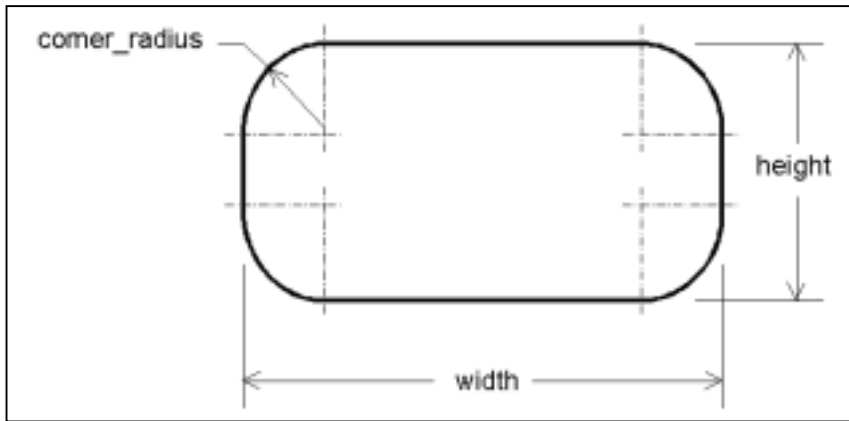
- cross\_section\_boundary.

A cross\_section\_boundary is a curve made up of several component curves but joined together to act as a single curve. The component curves are usually bounded by other surface intersections.

#### 4.2.80. Cross\_section\_radiused\_corner

The Cross\_section\_radiused\_corner is a type of Hvac\_cross\_section (see 4.2.150) taken through a piece of rectangular duct whose corners are radiused.

NOTE Figure 14 depicts a typical Cross\_section\_radiused\_corner.



**Figure 14 - Cross\_section\_radiused\_corner**

The data associated with a Cross\_section\_radiused\_corner are the following:

- height;
- width;
- corner\_radius.

#### **4.2.80.1 height**

This attribute specifies the distance between the horizontal flats as shown in Figure 14.

#### **4.2.80.2 width**

This attribute specifies the distance between the vertical flats as shown in Figure 14.

#### **4.2.80.3 corner\_radius**

This attribute specifies the radius of the fillet between a vertical face and a horizontal face.

### **4.2.81. Cross\_section\_rectangular**

The Cross\_section\_rectangular is a type of Hvac\_cross\_section (see **4.2.150**) applied to the cross section taken through a piece of rectangular duct in an hvac system.

The data associated with a Cross\_section\_rectangular are the following:

- height;
- width.

#### **4.2.81.1 height**

This attribute specifies the distance between the horizontal flats.

#### **4.2.81.2 width**

This attribute specifies the distance between the vertical flats.

### 4.2.82. Cross\_section\_round

The Cross\_section\_round is a type of Hvac\_cross\_section (see 4.2.150) which is applied to the cross section taken through a piece of round duct in an hvac system.

The data associated with a Cross\_section\_round are the following:

— radius.

This attribute specifies the distance from the centre of the cross section to a point on its circumference.

### 4.2.83. Cross\_section\_triangular

The Cross\_section\_triangular is a type of Hvac\_cross\_section (see 4.2.150) applied to the cross section taken through a piece of triangular duct in an hvac system.

The data associated with a Cross\_section\_triangular are the following:

— vertex\_1;

— vertex\_2;

— vertex\_3.

#### 4.2.83.1 vertex\_1

Vertex\_1 is a cartesian point which locates on of the three verticies of the triangular cross section. Vertex\_1 is required for each Cross\_section\_triangular.

#### 4.2.83.2 vertex\_2

Vertex\_2 is a cartesian point which locates on of the three verticies of the triangular cross section. Vertex\_2 is required for each Cross\_section\_triangular.

#### 4.2.83.3 vertex\_3

Vertex\_3 is a cartesian point which locates on of the three verticies of the triangular cross section. Vertex\_3 is required for each Cross\_section\_triangular.

### 4.2.84. Csg\_element

A Csg\_element is a type of Shape\_representation\_element (see 4.2.310) that is a regular, 3D geometric shape that is combined with other regular shapes through boolean operations to create a complex, 3D, solid model. Each Csg\_element is either: a Block (see 4.2.7), a Circular\_ellipsoid (see 4.2.61), a Cone (see 4.2.68), a Cylinder (see 4.2.86), an Eccentric\_cone (see 4.2.94), an Eccentric\_cylinder (see 4.2.95), an Eccentric\_pyramid (see 4.2.96), an Extrusion (see 4.2.111), a Faceted\_brep (see 4.2.113), a Hemisphere (see 4.2.139), a Pyramid (see 4.2.288), a Reducing\_torus (see 4.2.294), a Solid\_of\_revolution (see 4.2.321), a Sphere (see 4.2.326), a Square\_to\_round (see 4.2.329), a Torus (see 4.2.355), a Trimmed\_block (see 4.2.357), a Trimmed\_cone (see 4.2.358), a Trimmed\_cylinder (see 4.2.359), a Trimmed\_pyramid (see 4.2.360), a Trimmed\_sphere (see 4.2.361), a Trimmed\_torus (see 4.2.362).

### 4.2.85. Curve

## **ISO/CD 10303-227**

A Curve is a type of Wire\_and\_surface\_element (see **4.2.372**) that is a one-dimensional manifold in a space of dimension two or three. A Curve may be a Conic (see **4.2.69**), a Free\_form\_curve (see **4.2.125**), a Line (see **4.2.196**), a Polygon (see **4.2.283**), or a Vector (see **4.2.368**).

NOTE Informally, a Curve can be envisioned as the path of a point moving in its coordinate space.

### **4.2.86. Cylinder**

A Cylinder is a type of Csg\_element (see **4.2.84**) that is a 3D cylindrical solid primitive with end surfaces that are planar and are perpendicular to the axis. The size and shape of a Cylinder is completely described by two real values that represent the radius and length of the cylinder.

### **4.2.87. Design\_project**

A Design\_project is a task with a specifically defined purpose and scope that is used for the administration and management of plant designs.

The data associated with a Design\_project are the following:

- description;
- name;
- owner.

#### **4.2.87.1 description**

The description specifies a textual explanation or summary of the Design\_project.

#### **4.2.87.2 name**

The name specifies a textual label given to the Design\_project.

#### **4.2.87.3 owner**

The owner specifies the name of the organization that is responsible for the Design\_project.

### **4.2.88. Detail\_shape**

A Detail\_shape is a type of Shape\_representation (see **4.2.309**) that is the actual or intended external shape of a Plant\_item (see **4.2.260**). A Detail\_shape does not include the description of voids or other internal details of the shape of the Plant\_item.

NOTE Contrast Detail\_shape with Outline\_shape (see **4.2.228**) and Envelope\_shape (see **4.2.103**). A Detail\_shape more closely approximates the actual shape of the Plant\_item (see **4.2.260**) than either Envelope\_shape or Outline\_shape and is, therefore, likely to be more complex than either Envelope\_shape or Outline\_shape.

### **4.2.89. Document**

A Document is the identification of a logical collection of information about a particular subject.

The data associated with a Document are the following:

- document\_id;
- version\_id;
- document\_type;
- internal\_document\_reference.

#### **4.2.89.1 document\_id**

The document\_id specifies a unique identification for the Document.

#### **4.2.89.2 version\_id**

The version\_id specifies a unique identification of a revision of a particular Document.

#### **4.2.89.3 document\_type**

The document\_type specifies the kind of Document.

EXAMPLE A document\_type may be “coating specification”, “material test report”, “mill sheet”, “positive material identification record”, “specification”, “record”, “chart”, etc.

#### **4.2.89.4 internal\_document\_reference**

The internal\_document\_reference specifies a specific location within a Document where information is represented.

### **4.2.90. Ducting\_component**

A Ducting\_component is a type of Plant\_item (see **4.2.260**) that conveys gaseous matter or airborne, particulate matter. Each Ducting\_component may be one of the following: an Equipment\_breaching (see **4.2.105**), an Hvac\_ducting (see **4.2.151**), or a Process\_ducting (see **4.2.286**).

EXAMPLE A Ducting\_component that does not fall within one of the subtype categories may be cable trays, raceways, and other ducting used for routing and support of cables.

### **4.2.91. Ducting\_system**

A Ducting\_system is a type of Plant\_system (see **4.2.276**) that controls the temperature, humidity, cleanliness, and circulation of environmental or exhaust air as required in a Plant (see **4.2.258**). A Ducting\_system may be an Hvac\_system (see **4.2.176**).

The data associated with a Ducting\_system are the following:

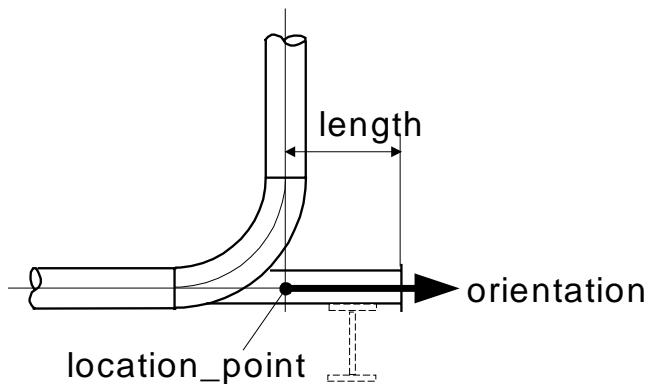
- type.

The type specifies a designation that classifies a Ducting\_system based on the kind of service that it provides.

**4.2.92. Dummy\_leg**

A Dummy\_leg is a type of Piping\_support (see 4.2.248) that is attached to a corner of bent part. The main body of it is usually a pipe but shape steel or plate is occasionally used as the material of the part. The Dummy\_leg is placed horizontally and supports the weight that acts perpendicularly to the axis of the main body.

NOTE Figure 15 depicts a typical Dummy\_leg.



**Figure 15 - Dummy\_leg**

The data associated with a Dummy\_leg are the following:

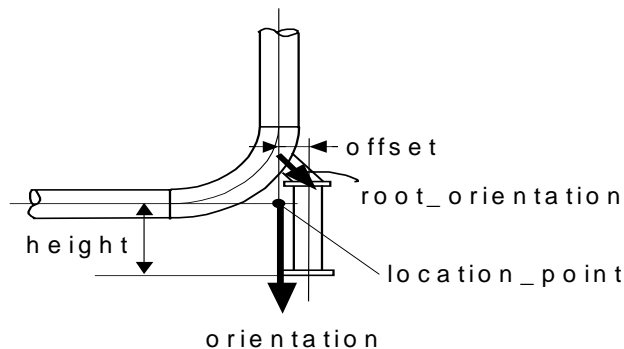
— length.

The length specifies the distance between the end face of the Dummy\_leg and the location\_point.

**4.2.93. Eccentric\_base\_elbow\_support**

An Eccentric\_base\_elbow\_support is a type of Base\_elbow\_support (see 4.2.3) positioned such that its vertical leg is shifted from the centreline of the pipe it supports.

NOTE Figure 16 depicts a typical Eccentric\_base\_elbow\_support.



**Figure 16 - Eccentric\_base\_elbow\_support**

The data associated with an Eccentric\_base\_elbow\_support are the following:

- offset;
- root\_orientation.

#### 4.2.93.1 offset

The offset is the perpendicular distance between the location\_point and the centreline of the main body of the Eccentric\_base\_elbow\_support.

#### 4.2.93.2 root\_orientation

The root\_orientation is the unit vector which gives the direction of the centreline of the inclined portion of the Eccentric\_base\_elbow\_support at the point where it supports the pipe.

### 4.2.94. Eccentric\_cone

An Eccentric\_cone is a type of Csg\_element (see 4.2.84) that consists of a Cone (see 4.2.68) with an axis that is not normal to the base.

### 4.2.95. Eccentric\_cylinder

An Eccentric\_cylinder is a type of Csg\_element (see 4.2.84) that consists of a Cylinder (see 4.2.86) with an axis that is not normal to the base.

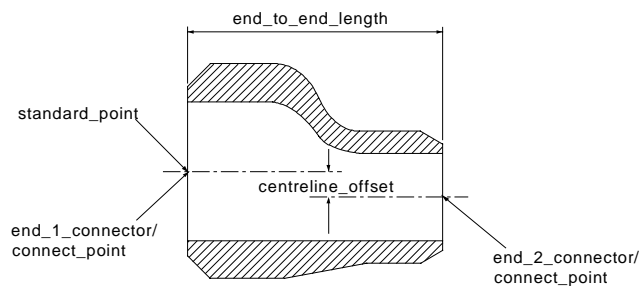
### 4.2.96. Eccentric\_pyramid

An Eccentric\_pyramid is a type of Csg\_element (see 4.2.84) that consists of a Pyramid (see 4.2.288) with an axis that is not normal to the base.

### 4.2.97. Eccentric\_reducer

An Eccentric\_reducer is a type of Reducer (see 4.2.292) where the small end is off-centre from the large end.

NOTE Figure 17 depicts a typical butt-weld Eccentric\_reducer. The end\_<number>\_connectors correspond to the end\_<number>\_connector attributes defined in Reducer (see 4.2.292).



**Figure 17 - Eccentric\_reducer**

The data associated with an Eccentric\_reducer are the following:

- centreline\_offset;
- flat\_side\_orientation.

#### 4.2.97.1 centreline\_offset

The centreline\_offset specifies the perpendicular distance between the centreline of the large end of the Reducer (see 4.2.292) and the centreline of the smaller end of the Reducer.

#### 4.2.97.2 flat\_side\_orientation

The flat\_side\_orientation specifies the direction of the straight side of the Eccentric\_reducer.

NOTE 1 The direction of the straight side is typically specified as up or down.

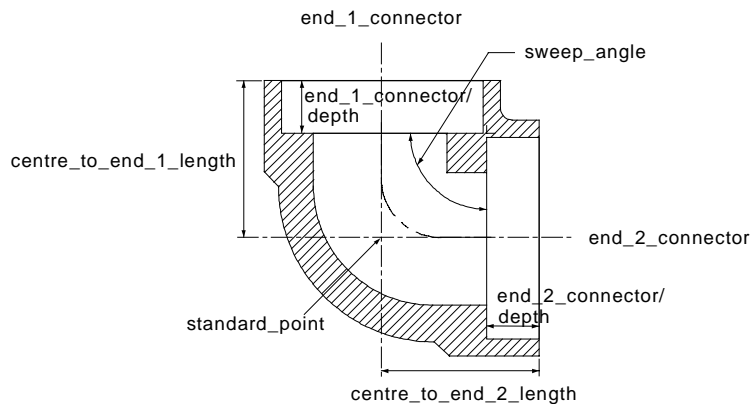
NOTE 2 The straight side of the Eccentric\_reducer corresponds to the side where the ends of the Eccentric\_reducer have a common tangent point parallel to the centreline axes of the Eccentric\_reducer.

NOTE 3 Eccentric swage is a synonym for Eccentric Reducer which is normally used for smaller sizes.

### 4.2.98. Elbow

An Elbow is a type of Fitting (see 4.2.117) that is used to change the direction of piping.

NOTE Figure 18 depicts a typical socket-weld Elbow.



**Figure 18 - Elbow**

The data associated with an Elbow are the following:

- centre\_to\_end\_1\_length;
- centre\_to\_end\_2\_length;
- centreline\_radius;
- end\_1\_connector;

- end\_2\_connector;
- sweep\_angle;
- type.

#### **4.2.98.1 centre\_to\_end\_1\_length**

The `centre_to_end_1_length` specifies the distance from the centre of the Elbow (i.e., where the centrelines for the two ends intersect) to the end-one face. It may be specified as a single value or as a range of values.

NOTE See annex L for a discussion of attributes that may be assigned a single value or a range of values.

#### **4.2.98.2 centre\_to\_end\_2\_length**

The `centre_to_end_2_length` specifies the distance from the centre of the Elbow (i.e., where the centrelines for the two ends intersect) to the end-two face. It may be specified as a single value or as a range of values.

NOTE See annex L for a discussion of attributes that may be assigned a single value or a range of values.

#### **4.2.98.3 centreline\_radius**

The `centreline_radius` specifies the distance from the centreline of the Elbow to the intersection of the perpendicular projection of the centreline taken at the point where the Elbow centreline ends or where the inlet and outlet ends of the Elbow centreline become straight lines. It may be specified as a single value or as a range of values.

NOTE See annex L for a discussion of attributes that may be assigned a single value or a range of values.

#### **4.2.98.4 end\_1\_connector**

The `end_1_connector` specifies the `Piping_connector` (see **4.2.242**) designated as end one.

#### **4.2.98.5 end\_2\_connector**

The `end_2_connector` specifies the `Piping_connector` (see **4.2.242**) designated as end two.

#### **4.2.98.6 sweep\_angle**

The `sweep_angle` specifies the included angle formed between two lines that are parallel to the end-one and end-two faces of the Elbow, measured at their point of intersection (the centre of radius of the Elbow). It may be specified as a single value or as a range of values.

NOTE See annex L for a discussion of attributes that may be assigned a single value or a range of values.

#### **4.2.98.7 type**

The `type` specifies a designation that classifies the Elbow.

EXAMPLE Examples of elbow designations include long radius, short radius, reducing, and street.

### **4.2.99. Electrical\_component**

An `Electrical_component` is a type of `Plant_item` (see **4.2.260**) that is an individually identifiable and functional part of an `Electrical_system` (see **4.2.101**).

EXAMPLE Examples of `Electrical_components` include cable tray, wireway, conduit, ductbank, cables, switches, relays, motor control centres, and junction boxes.

### **4.2.100.      `Electrical_connector`**

An `Electrical_connector` is a type of `Plant_item_connector` (see **4.2.265**) that is intended to establish an electrical connection (signal or power) between two `Plant_item` (see **4.2.260**) objects.

The data associated with an `Electrical_connector` are the following:

— `type`.

The `type` specifies the designation that describes the functional behaviour of the `Electrical_connector`.

### **4.2.101.      `Electrical_system`**

An `Electrical_system` is a type of `Plant_system` (see **4.2.276**) that is a system of wiring, switches, relays, and other equipment associated with receiving and distributing electrical power.

The data associated with an `Electrical_system` are the following:

— `system_voltage_designation`;

— `type`.

#### **4.2.101.1 `system_voltage_designation`**

The `system_voltage_designation` is the rated voltage of the system.

#### **4.2.101.2 `type`**

The `type` specifies a designation that classifies the `Electrical_system` based on the kind of service that it provides.

### **4.2.102.      `Electricity_transference`**

An `Electricity_transference` is a type of `Plant_item_connection` (see **4.2.263**) that identifies the purpose or role of the connection as being the transfer of electrical current or signal.

### **4.2.103.      `Envelope_shape`**

An `Envelope_shape` is a type of `Shape_representation` (see **4.2.309**) that is a 3D spatial volume that completely encloses or bounds a `Plant_item` (see **4.2.260**). An `Envelope_shape` is a very simple geometric shape, such as a box, that encloses the plant item. An `Envelope_shape` may, but need not, include clearance or access spaces associated with the plant item.

NOTE Contrast Envelope\_shape with Detail\_shape (see 4.2.88) and Outline\_shape (see 4.2.228).

## **4.2.104. Equipment**

An Equipment is a type of Plant\_item (see 4.2.260) that is treated as a single and self-contained unit that provides a function. Each Equipment may be an Inline\_equipment (see 4.2.182).

The data associated with an Equipment are the following:

- characteristics;
- equipment\_type;
- heat\_tracing\_type;
- insulation\_specification;
- rated\_temperature;
- shock\_qualification\_status;
- vibration\_amplitude;
- vibration\_frequency.

### **4.2.104.1 characteristics**

The characteristics specifies functional attributes of the Equipment.

EXAMPLE Characteristics of a pump may be that it operates at 80% efficiency while pumping 1250 gallons per minute.

### **4.2.104.2 equipment\_type**

The equipment\_type specifies a classification of an Equipment based on its performance characteristics.

EXAMPLE Examples of equipment\_type classifications include compressor, engine, furnace, gear box, heat exchanger, pressure vessel, pump, silo, tank, and turbine.

### **4.2.104.3 heat\_tracing\_type**

The heat\_tracing\_type specifies the means utilized to impart a temperature increase to the Equipment by an external wrapping or coiling.

EXAMPLE Examples of heat\_tracing\_types include, but are not limited to, electrical or steam.

### **4.2.104.4 insulation\_specification**

The insulation\_specification specifies the document that defines the insulation requirements for the Equipment.

### **4.2.104.5 rated\_temperature**

## **ISO/CD 10303-227**

The rated\_temperature applies to the maximum temperature of the environment where the operating equipment will be installed.

### **4.2.104.6 shock\_qualification\_status**

The shock\_qualification\_status for hvac applications falls into an "A" or "B" category. Under category "A" an hvac component can withstand the full limits of shock and still operate. Under the "B" category the hvac component will not be operational after full shock but the component will remain intact.

### **4.2.104.7 vibration\_amplitude**

The vibration\_amplitude is the magnitude, or amount, of displacement, velocity, or acceleration, measured from the "at rest" value. The amplitude of a vibration signal can be expressed in terms of "peak" level, "Peak-to-peak" level, or RMS level. It is somewhat of a de facto standard that Displacement is peak-to-peak, Velocity is peak, and Acceleration is RMS.

### **4.2.104.8 vibration\_frequency**

Vibration\_frequency refers to the pitch of a sound generated by vibration within an hvac system. Usually measured in cycles per second (cps).

## **4.2.105. Equipment\_breaching**

An Equipment\_breaching is a type of Ducting\_component (see **4.2.90**) consisting of a type of ductwork connected to a piece of Equipment (see **4.2.104**) for the purpose of exhausting gases.

## **4.2.106. Equipment\_trim\_piping**

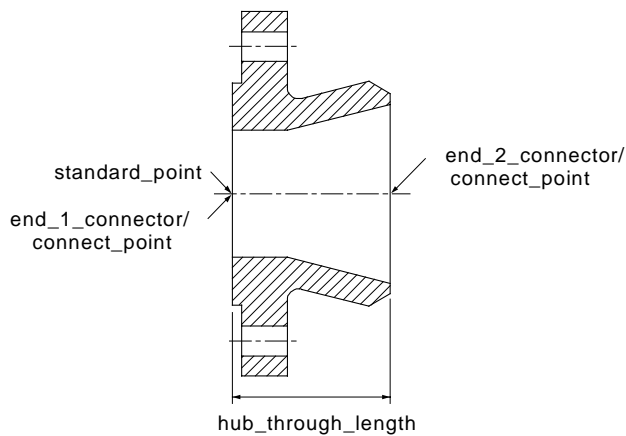
An Equipment\_trim\_piping is piping connected to a piece of Equipment (see **4.2.104**) that performs a function integral to the Equipment.

NOTE The piping is normally designed and possibly provided or installed by the Equipment manufacturer. Piping of this nature is normally of nominal size two inches and below.

## **4.2.107. Expander\_flange**

An Expander\_flange is a type of Flange (see **4.2.119**) that provides a transition from a smaller to a larger diameter Pipe (see **4.2.236**) at a flanged connection.

NOTE Figure 19 depicts a typical Expander\_flange.



**Figure 19 - Expander flange**

### 4.2.108. External\_classification

An `External_classification` is a designation and description that classifies a `Plant_item` (see 4.2.260), `Plant` (see 4.2.258), `Plant_system` (see 4.2.276), or `Plant_item_connector` (see 4.2.265) based on predefined tables or sources defined externally to this part. The designation is a reference to the predefined table or source.

The data associated with an `External_classification` are the following:

- description;
- name;
- source.

#### 4.2.108.1 description

The description specifies a textual explanation or summary of the `External_classification`.

#### 4.2.108.2 name

The name specifies a textual label given to the `External_classification`.

#### 4.2.108.3 source

The source specifies a designation that identifies a table or document that contains a list of candidate classifications that the name and description are drawn from.

### 4.2.109. Externally\_defined\_document

An `externally_defined_document` is a `Document` (see 4.2.89) that is referenced from a source outside the context of an exchange.

The data associated with an `Externally_defined_document` are the following:

- source\_id;

— source\_description.

#### **4.2.109.1 source\_id**

The source\_id specifies a unique identification of the external origin of the document.

EXAMPLE A source\_id may be “ANSI”, “ISO”, “ISO 13584”, “DIN”, “JIS”, “PFI”, “Joe’s notebook” or another external source.

#### **4.2.109.2 source\_description**

The source\_description is text that characterizes the external\_source.

### **4.2.110. Externally\_defined\_user\_defined\_attribute\_value**

An Externally\_defined\_user\_defined\_attribute\_value is a type of User\_defined\_attribute\_value (see **4.2.366**).

The data associated with an Externally\_defined\_user\_defined\_attribute\_value are the following:

— source;

The source specifies a textual identification of the reference resource in which the User\_defined\_attribute\_value is described.

### **4.2.111. Extrusion**

An Extrusion is a type of Csg\_element (see **4.2.84**) that is a closed, 2D profile swept through a linear distance in space.

### **4.2.112. Facet\_trigon**

A Facet\_trigon is a planar, polygonal surface with three sides.

NOTE In 3D computer models, curved surfaces are sometimes represented by a collection of Facets that approximate the curved surface.

### **4.2.113. Faceted\_brep**

A Facet\_brep is a type of Csg\_element (see **4.2.84**).

### **4.2.114. Faceted\_surface\_representation**

A Faceted\_surface\_representation is a type of Site\_shape\_representation (see **4.2.315**) that consists of a collection of Facet\_trigon (see **4.2.112**) objects that represent the topography of a Site (see **4.2.313**).

### **4.2.115. Family\_definition**

A **Family\_definition** is a **Plant\_item\_definition** (see 4.2.267) that characterizes a set of **Piping\_component** (see 4.2.240) objects based on common physical characteristics. Physical characteristics may be specified as a specific value or as a range of values.

NOTE See annex L for a discussion of attributes that may be assigned a single value or a range of values.

EXAMPLE A **Piping\_specification** (see 4.2.245) describes a **Family\_definition**, such as a class of elbows made of stainless steel that are long radius elbows between six inches and twenty four inches in diameter.

The data associated with a **Family\_definition** are the following:

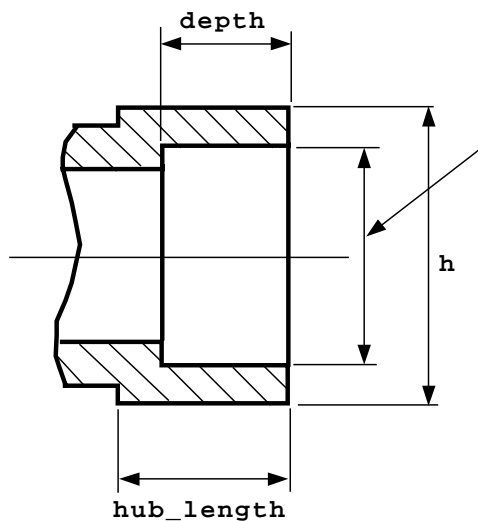
— **family\_classification\_description**.

The **family\_classification\_description** specifies a textual explanation of the principle characteristics that vary within the family.

#### 4.2.116. Female\_end

A **Female\_end** is a type of **Piping\_connector** (see 4.2.242) end type that forms a recessed opening at the connector to support the insertion of a compatible male connector.

NOTE Figure 20 depicts a typical **Female\_end**.



**Figure 20 - Female\_end**

The data associated with a **Female\_end** are the following:

— **depth**;

— **hub\_inside\_diameter**;

— **hub\_length**;

— **hub\_outside\_diameter**.

#### 4.2.116.1 depth

The depth specifies the distance from the face of the Piping\_connector (see 4.2.242) to the depth of relief. It may be specified as a single value or as a range of values.

NOTE See annex L for a discussion of attributes that may be assigned a single value or a range of values.

#### 4.2.116.2 hub\_inside\_diameter

The hub\_inside\_diameter specifies the diameter of the opening at the hub. It may be specified as a single value or as a range of values.

NOTE See annex L for a discussion of attributes that may be assigned a single value or a range of values.

#### 4.2.116.3 hub\_length

The hub\_length specifies the distance from the face of the Plant\_item\_connector (see 4.2.265) to the point where the hub size transitions to the body size of the Plant\_item (see 4.2.260). It may be specified as a single value or as a range of values.

NOTE See annex L for a discussion of attributes that may be assigned a single value or a range of values.

#### 4.2.116.4 hub\_outside\_diameter

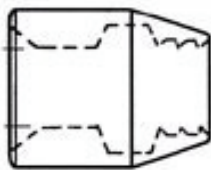
The hub\_outside\_diameter specifies the external diameter of the hub. It may be specified as a single value or as a range of values.

NOTE See annex L for a discussion of attributes that may be assigned a single value or a range of values.

### 4.2.117. Ferrule

A Ferrule is a metal cylinder placed over a hose end to affix the fitting to the hose.

NOTE Figure 21 depicts a typical Ferrule.



**Figure 21 - Ferrule**

The data associated with a Ferrule are the following:

- end\_1\_connector;
- end\_2\_connector;
- length.

**4.2.117.1 end\_1\_connector**

The end\_1\_connector specifies the Piping\_connector (see 4.2.242) designated as end one.

**4.2.117.2 end\_2\_connector**

The end\_2\_connector specifies the Piping\_connector (see 4.2.242) designated as end two.

**4.2.117.3 length**

The length is the distance between the end\_1\_connector and the end\_2\_connector.

**4.2.118. Fitting**

A Fitting is a type of Piping\_component (see 4.2.240) used to join or terminate sections of Pipe (see 4.2.236) or provide changes of direction or branching in a Piping\_system (see 4.2.249). Each Fitting may be one of the following: a Blank (see 4.2.5), a Bushing (see 4.2.15), a Coupling (see 4.2.76), a Cross (see 4.2.77), an Elbow (see 4.2.98), a Flange (see 4.2.119), an Insert (see 4.2.184), a Lap\_joint\_stub\_end (see 4.2.194), a Lateral (see 4.2.195), an Olet (see 4.2.225), an Orifice\_plate (see 4.2.227), a Pipe\_closure (see 4.2.237), a Reducer (see 4.2.292), a Spacer (see 4.2.322), a Tee (see 4.2.351), a Union (see 4.2.364), or a Y\_type\_lateral (see 4.2.373).

**4.2.119. Flange**

A Flange is a type of Fitting (see 4.2.117) that is an annular collar that permits a bolted connection to a similar collar. Each Flange contains two end connectors, one of which shall be a Piping\_connector (see 4.2.242) of type Flanged\_end. Each Flange may be one of the following: a Blind\_flange (see 4.2.6), an Expander\_flange (see 4.2.107), an Orifice\_flange (see 4.2.226), or a Reducing\_flange (see 4.2.293). Each Flange may be one of the following: a Lap\_joint\_flange (see 4.2.193), a Slip\_on\_flange (see 4.2.317), a Socket\_weld\_flange (see 4.2.320), a Threaded\_flange (see 4.2.353), or a Weld\_neck\_flange (see 4.2.370).

The data associated with a Flange are the following:

- end\_1\_connector;
- end\_2\_connector;
- hole\_straddle\_centreline\_orientation;
- hub\_through\_length;
- hub\_weld\_point\_diameter.

**4.2.119.1 end\_1\_connector**

The end\_1\_connector specifies the Piping\_connector (see 4.2.242) at the flange face.

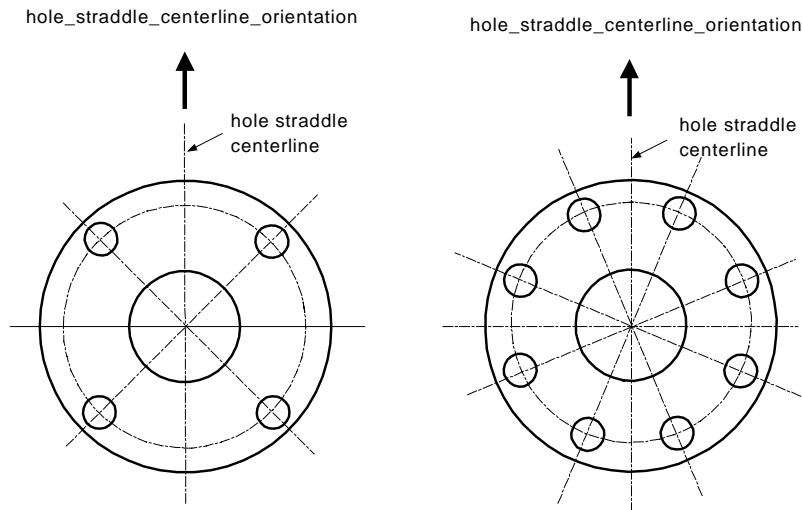
**4.2.119.2 end\_2\_connector**

The end\_2\_connector specifies the Piping\_connector (see 4.2.242) at the hub face.

#### 4.2.119.3 hole\_straddle\_centreline\_orientation

The hole\_straddle\_centreline\_orientation is the orientation of the hole straddle centreline of the Flange in plant coordinates. The hole straddle centreline is the line on the flange surface connected between the centre of the Flange and the middle point of two neighboring bolt holes.

NOTE Figure 22 depicts hole\_straddle\_centreline\_orientation.



**Figure 22 - Hole\_straddle\_centreline\_orientation**

NOTE The receiving system may transform the plant coordinates into a local coordinate system if necessary.

#### 4.2.119.4 hub\_through\_length

The hub\_through\_length specifies the distance between the flange face and the hub face. It may be specified as a single value or as a range of values.

NOTE See annex L for a discussion of attributes that may be assigned a single value or a range of values.

#### 4.2.119.5 hub\_weld\_point\_diameter

The hub\_weld\_point\_diameter specifies the outside diameter of the hub at the point of connection between the flange and the pipe. It may be specified as a single value or as a range of values.

NOTE See annex L for a discussion of attributes that may be assigned a single value or a range of values.

### 4.2.120. Flanged

A Flanged is a type of Piping\_connector (see 4.2.242) end engagement type consisting of a circular disk of material with holes around the circumference and a facing style.

NOTE The holes are used to bolt together two connected flanges. The facing is the mating surface that in conjunction with a gasket forms a tight connection by the pressure of the two connected flanged connectors. A flanged connection can be disassembled.

#### 4.2.121. Flanged\_end

A Flanged\_end is a type of Piping\_connector (see 4.2.242) end type that is a circular disk of material that supports the insertion of bolts to mate with a compatible Flanged\_end.

NOTE Figure 23 depicts a typical Flanged\_end.

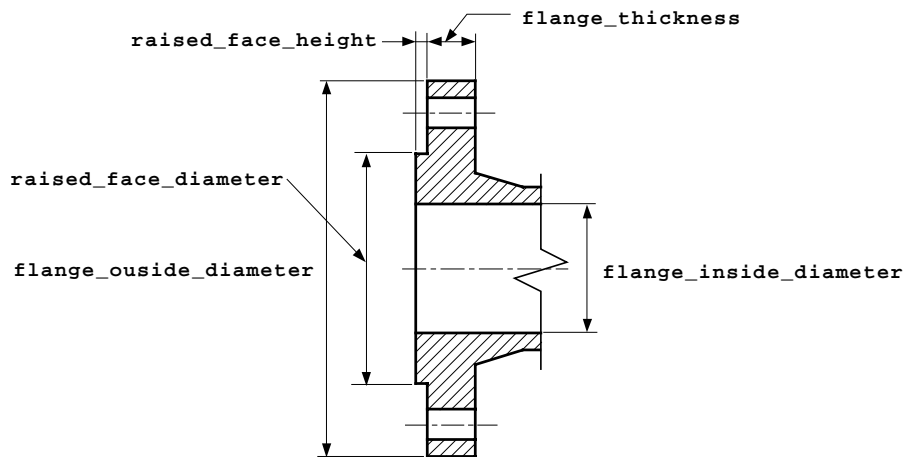


Figure 23 - Flanged\_end

The data associated with a Flanged\_end are the following:

- face\_finish;
- face\_type;
- flange\_inside\_diameter;
- flange\_outside\_diameter;
- flange\_thickness;
- raised\_face\_diameter;
- raised\_face\_height;
- ring\_bottom\_radius;
- ring\_diameter;
- ring\_width.

#### 4.2.121.1 face\_finish

The face\_finish specifies a description of the Flange (see 4.2.119) face surface roughness and groove pattern.

#### 4.2.121.2 face\_type

The face\_type specifies a classification of the mating surface of a Flange (see 4.2.119) based on its shape characteristics.

EXAMPLE Examples of face\_type designations include raised\_face, flat\_face, ring\_type\_joint, male\_face\_of\_male\_and\_female, female\_face\_of\_male\_and\_female, male\_face\_of\_tongue\_and\_groove, and female\_face\_of\_tongue\_and\_groove.

NOTE Figures 24 to 28 depict these face types.

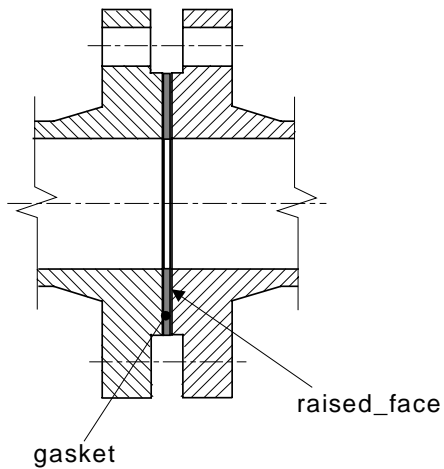


Figure 24 - Raised face flange

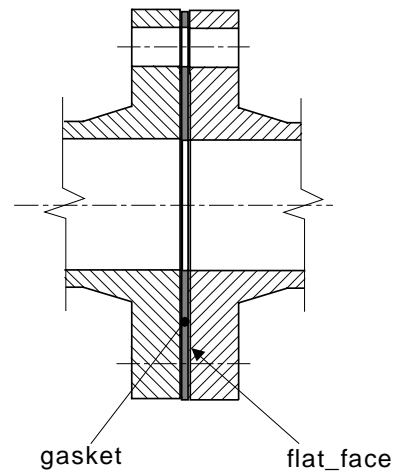


Figure 25 – Flat face flange

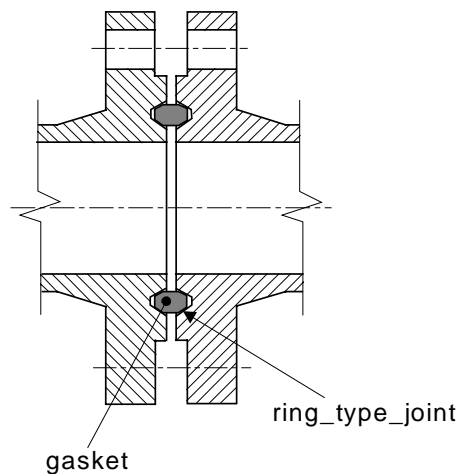
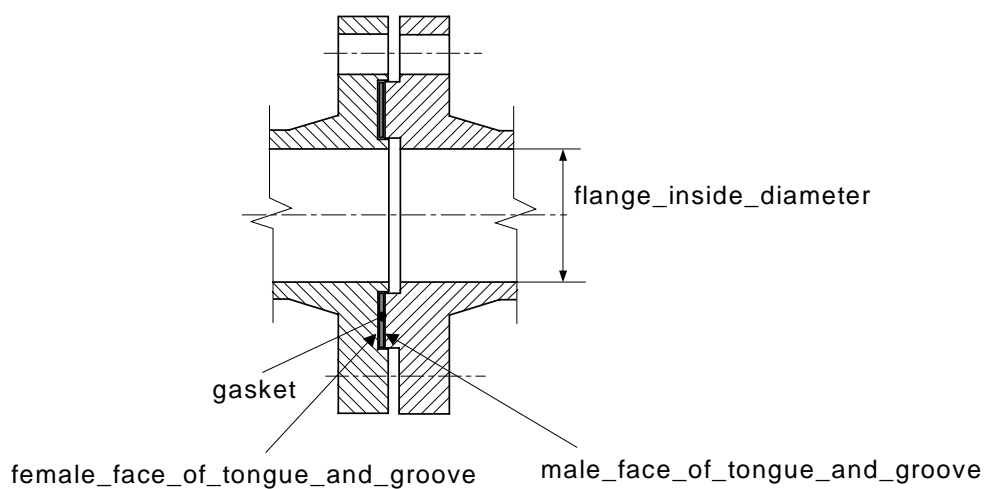
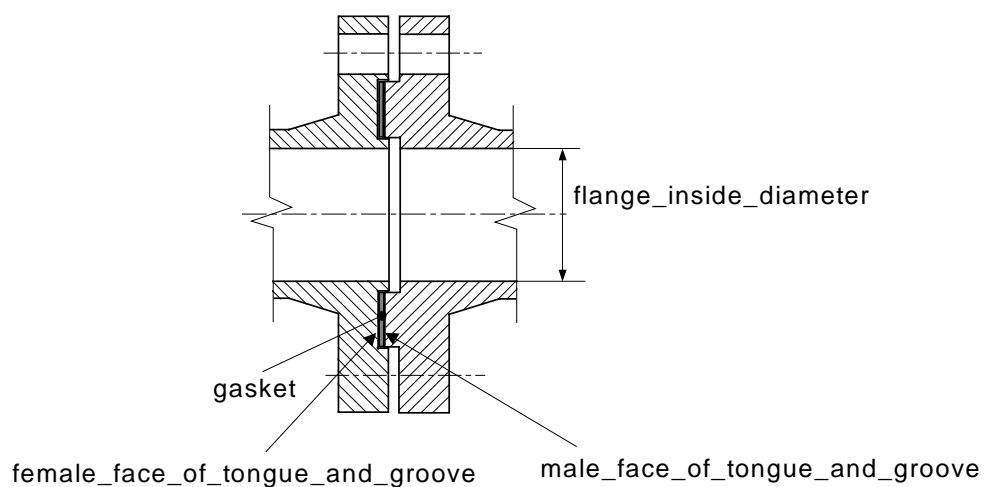


Figure 26 - Ring type joint flange



**Figure 27 - Male and female flange**



**Figure 28 - Tongue and groove flange**

#### 4.2.121.3 flange\_inside\_diameter

The flange\_inside\_diameter specifies the interior diameter of the Flange (see 4.2.119) at the working point. It may be specified as a single value or as a range of values.

NOTE See annex L for a discussion of attributes that may be assigned a single value or a range of values.

#### **4.2.121.4 flange\_outside\_diameter**

The `flange_outside_diameter` specifies the external diameter of the Flange (see **4.2.119**). It may be specified as a single value or as a range of values.

NOTE See annex L for a discussion of attributes that may be assigned a single value or a range of values.

#### **4.2.121.5 flange\_thickness**

The `flange_thickness` specifies the distance between the inside and outside Flange (see **4.2.119**) disk surfaces, measured at the disk perimeter. It may be specified as a single value or as a range of values.

NOTE See annex L for a discussion of attributes that may be assigned a single value or a range of values.

#### **4.2.121.6 raised\_face\_diameter**

The `raised_face_diameter` specifies the diameter measured across the elevated portion of the mating surface of a Flange (see **4.2.119**). It may be specified as a single value or as a range of values.

NOTE See annex L for a discussion of attributes that may be assigned a single value or a range of values.

#### **4.2.121.7 raised\_face\_height**

The `raised_face_height` specifies the perpendicular distance measured from the elevated portion of the Flange (see **4.2.119**) mating surface to the lower Flange surface. It may be specified as a single value or as a range of values.

NOTE See annex L for a discussion of attributes that may be assigned a single value or a range of values.

#### **4.2.121.8 ring\_bottom\_radius**

The `ring_bottom_radius` specifies the radial measure of the bottom corners of a ring in raised face. The `ring_bottom_radius` may not be specified for a particular `Flanged_end`, but when specified must be accompanied by `raised_face_diameter`, `raised_face_height`, `ring_diameter`, and `ring_width`.

#### **4.2.121.9 ring\_diameter**

The `ring_diameter` specifies the diameter of a ring in the raised-face portion of a `Flanged_end`. The `ring_diameter` may not be specified for a particular `Flanged_end`, but when specified must be accompanied by `raised_face_diameter`, `raised_face_height`, `ring_bottom_radius`, and `ring_width`.

#### **4.2.121.10 ring\_width**

The `ring_width` specifies the width of the groove formed by a ring in the raised-face portion of a `Flanged_end`. The `ring_width` may not be specified for a particular `Flanged_end`, but when specified must be accompanied by `raised_face_diameter`, `raised_face_height`, `ring_bottom_radius`, and `ring_diameter`.

### 4.2.122. Flared\_end

A Flared\_end is an end\_type where the inside\_diameter and outside\_diameter at the end is increased with no change in thickness forming a kind of lip.

The data associated with a Flared\_end are the following:

- diameter;
- thickness.

#### 4.2.122.1 diameter

The diameter is the inside diameter at the end of the flare (largest point).

#### 4.2.121.2 thickness

The thickness is the Fitting (see 4.2.118) thickness at the point the diameter is measured.

### 4.2.123. Flexible\_connection

A Flexible\_connection is a type of Plant\_item\_connection (see 4.2.263) in which two Plant\_item\_connector (see 4.2.265) objects are in physical contact, though there is no implication concerning the freedom of motion of the connected Plant\_item (see 4.2.260) objects.

EXAMPLE The pump driver may be connected to an electrical cable at its terminal using a Flexible\_connection; the cable need not rotate when the pump is rotated, but contact must be preserved.

### 4.2.124. Fluid\_transference

A Fluid\_transference is a type of Plant\_item\_connection (see 4.2.263) that identifies the purpose or role of the connection as being the transfer of gas, vapour, liquid or solid material.

### 4.2.125. Free\_form\_curve

A Free\_form\_curve is a type of Curve (see 4.2.85). It is a one-dimensional, contiguous set of points.

### 4.2.126. Functional\_connection\_definition\_satisfaction

A Functional\_connection\_definition\_satisfaction is the assignment of an actual Connection\_definition (see 4.2.72) to a functional Connection\_definition for the purpose of satisfying the functional requirements with a physical object.

The data associated with a Functional\_connection\_definition\_satisfaction are the following:

- functional\_connection\_definition;
- physical\_connection\_definition.

#### **4.2.126.1 functional\_connection\_definition**

The `functional_connection_definition` is a reference to the `connection_id` of the `Connection_definition` (see 4.2.72) object that describes the functional view of the connection.

#### **4.2.126.2 physical\_connection\_definition**

The `physical_connection_definition` is a reference to the `connection_id` of the `Connection_definition` object that describes the physical view of the connection that satisfies the function specified by the functional view of the definition of the connection.

### **4.2.127. Functional\_connection\_occurrence\_satisfaction**

A `Functional_connection_occurrence_satisfaction` is the assignment of an actual `Plant_item_connection_occurrence` (see 4.2.264) to a functional `Plant_item_connection_occurrence` for the purpose of satisfying the functional requirements with a physical object. The data associated with a `Functional_connection_occurrence_satisfaction` are the following:

— `physical_connection`.

The `physical_connection` is a reference to the `connection_id` of the occurrence of the connection that describes the physical view of the connection that satisfies the function specified by the functional view of the occurrence of the connection.

### **4.2.128. Functional\_connector**

A `Functional_connector` is a type of `Plant_item_connector_occurrence` (see 4.2.266) that represents the functional or logical aspect of the `Plant_item_connector_occurrence`. Each `Functional_connector` is either: a `Line_plant_item_branch_connector` (see 4.2.202) or a `Line_plant_item_connector` (see 4.2.204).

### **4.2.129. Functional\_connector\_definition\_satisfaction**

A `Functional_connector_definition_satisfaction` is the assignment of an actual `Connector_definition` (see 4.2.75) to a functional `Connector_definition` for the purpose of satisfying the functional requirements with a physical object.

### **4.2.130. Functional\_connector\_occurrence\_satisfaction**

A `Functional_connector_occurrence_satisfaction` is the assignment of an actual `Physical_connector` (see 4.2.234) to a `Functional_connector` (see 4.2.128) for the purpose of satisfying the functional requirements with a physical object.

### **4.2.131. Functional\_design\_view**

A `Functional_design_view` is a type of `Plant_item_design_view` (see 4.2.268) that indicates that data associated with the `Plant_item` (see 4.2.260) are the logical characteristics of a `Plant_item` rather than the physical.

The data associated with a Functional\_design\_view are the following:

- tag\_number.

The tag\_number specifies an optional identifier assigned to the Plant\_item (see 4.2.260) for purposes of functional identification and eventual physical tracking.

#### **4.2.132. Functional\_plant**

A Functional\_plant is a Plant (see 4.2.258) that is the identification of a view of the Plant that aggregates the functional characteristics of the Plant.

#### **4.2.133. Functional\_plant\_item\_satisfaction**

A Functional\_plant\_item\_satisfaction is the assignment of a Physical\_design\_view (see 4.2.235) to a Functional\_design\_view (see 4.2.131) for the purpose of satisfying the functional requirements with a physical object.

#### **4.2.134. Functional\_plant\_satisfaction**

A Functional\_plant\_satisfaction is the assignment of an actual Planned\_physical\_plant (see 4.2.256) to a Functional\_plant (see 4.2.132) for the purpose of satisfying the functional requirements with a physical object.

The data associated with a Functional\_plant\_satisfaction are the following:

- functional\_plant;

- planned\_physical.

##### **4.2.134.1 functional\_plant**

The functional\_connection\_definition is a reference to the plant\_id of the Functional\_plant object that describes the functional view of the connection.

##### **4.2.134.2 planned\_physical**

The planned\_physical is a reference to the plant\_id of the Planned\_physical\_plant object that describes the physical view of the plant that satisfies the function specified by the functional view of the plant.

#### **4.2.135. Gasket**

A Gasket is a type of Piping\_component (see 4.2.240) that seals a connection between two connectors.

NOTE Gaskets are primarily used with Flanged (see 4.2.120) Plant\_item\_connector (see 4.2.265).

The data associated with a Gasket are the following:

## ISO/CD 10303-227

— compressed\_thickness;

— uncompressed\_thickness.

### 4.2.135.1 compressed\_thickness

The compressed\_thickness specifies the distance between the two parallel surfaces of the Gasket in its compressed state in a connection. It may be specified as a single value or as a range of values.

NOTE See annex L for a discussion of attributes that may be assigned a single value or a range of values.

### 4.2.135.2 uncompressed\_thickness

The uncompressed\_thickness specifies the as-procured distance between the two parallel surfaces of the Gasket. It may be specified as a single value or as a range of values.

NOTE See annex L for a discussion of attributes that may be assigned a single value or a range of values.

## 4.2.136. Gis\_position

A Gis\_position is the positioning and orientation information necessary for transforming coordinate values between a local coordinate space and the global coordinate system of earth. Transformation procedures depend upon the geographic information system (GIS) coordinate system. Each Gis\_position object designates the global position and orientation of a Site\_shape\_-representation (see 4.2.315).

The data associated with a Gis\_position are the following:

— height;

— scale;

— system;

— x\_axis\_delta\_x;

— x\_axis\_delta\_y;

— x\_coordinate;

— y\_coordinate;

— zone.

### 4.2.136.1 height

The height specifies the distance above sea level or reference level in the GIS coordinate system.

### 4.2.136.2 scale

The scale specifies a transformation factor applied to the conversion of point coordinates between a local coordinate system and a GIS coordinate system. The precise application of the transformation will depend on the GIS system.

#### **4.2.136.3 system**

The system specifies the identifier of the GIS system being used.

EXAMPLE Gauss-Krueger, Universal Transverse Mercator (UTM), and State Plane are examples of GIS systems used for global positioning.

#### **4.2.136.4 x\_axis\_delta\_x**

The x\_axis\_delta\_x specifies the abscissa value of the end point of a vector indicating the positive x-axis of GIS coordinate space in the local coordinate system.

#### **4.2.136.5 x\_axis\_delta\_y**

The x\_axis\_delta\_y specifies the ordinate value of the end point of a vector indicating the orientation or the positive x-axis of GIS coordinate space in the local coordinate system.

EXAMPLE The GIS coordinate system XY00 has an origin at the intersection of the equator and the Greenwich meridian. The x-axis of the coordinate system runs East (positive) and West (negative). The y-axis runs North (positive) and South (negative). The positive z-axis is up (above sea level or the reference level in the GIS coordinate system). The negative z-axis is down (below sea level or the reference level in the GIS coordinate system). An x\_axis\_delta\_x of 1.0 and x\_axis\_delta\_y of 1.0 indicates x axis of the GIS coordinate space makes a +45° angle with respect to the x axis of the local coordinate; if the local coordinate space were superimposed on the GIS coordinate space, the positive x-axis of the local coordinate system would point in a South-East direction (-45°).

#### **4.2.136.6 x\_coordinate**

The x\_coordinate specifies the distance from the y-axis of the coordinate space defined by the GIS system and zone.

#### **4.2.136.7 y\_coordinate**

The y\_coordinate specifies the distance from the x-axis of the coordinate space defined by the GIS system and zone.

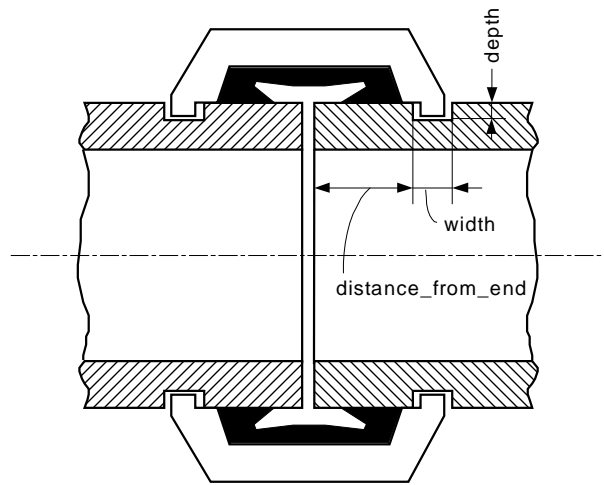
The zone specifies a subdivision of the earth's surface based on the GIS system.

EXAMPLE The Gauss-Krueger GIS system subdivides the earth into 120 zones that are 3° in longitudinal width. Each zone is identified as 3°, 6°, 9°, etc., from the Greenwich meridian.

### **4.2.137. Grooved\_end**

A Grooved\_end is a type of Piping\_connector (see **4.2.242**) end type that contains a circumferential groove cut or is rolled on a pipe surface for a grooved joint connection.

NOTE Figure 29 depicts a typical Grooved\_end.



**Figure 29 - Grooved\_end**

The data associated with a Grooved\_end are the following:

- depth;
- distance\_from\_end;
- width.

#### **4.2.137.1 depth**

The depth specifies the distance between the outer surface of the Pipe (see **4.2.236**) and the bottom of the groove. It may be specified as a single value or as a range of values.

NOTE See annex L for a discussion of attributes that may be assigned a single value or a range of values.

#### **4.2.137.2 distance\_from\_end**

The distance\_from\_end specifies the distance between the end of the Pipe (see **4.2.236**) and the inner edge of the groove. It may be specified as a single value or as a range of values.

NOTE See annex L for a discussion of attributes that may be assigned a single value or a range of values.

#### **4.2.137.3 width**

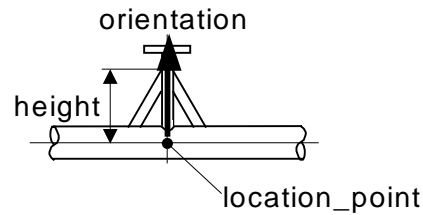
The width specifies the distance between the inner edge and the outer edge of the groove. It may be specified as a single value or as a range of values.

NOTE See annex L for a discussion of attributes that may be assigned a single value or a range of values.

### **4.2.138. Gusset**

A Gusset is a type of Reinforcing\_component (see 4.2.296) that is a tensile member placed diagonally between run pipe and branch pipe, and prevents the branch from breaking or deforming.

NOTE Figure 30 depicts a Gusset.



**Figure 30 - Gusset**

The data associated with a Gusset are the following:

— height.

The height is the distance between the location point and the most outer point of the Gusset welded to the branch pipe. It may be specified as a single value or as a range of values.

NOTE See annex L for a discussion of attributes that may be assigned a single value or a range of values.

#### **4.2.139. Hemisphere**

A Hemisphere is a type of Csg\_element (see 4.2.84) that is formed by cutting a Sphere (see 4.2.326) with a plane that passes through the centre point of the Sphere and removing one section.

#### **4.2.140. Hexagon\_head\_bolt**

A Hexagon\_head\_bolt is a type of a Bolt (see 4.2.8) that has a hexagonal head at one end and a screw thread on the other.

The data associated with a Hexagon\_head\_bolt are the following:

— length.

The length specifies the distance from the inner face of the hexagonal head to the tip of the screw thread. It may be specified as a single value or as a range of values.

NOTE See annex L for a discussion of attributes that may be assigned a single value or a range of values.

#### **4.2.141. Hierarchically\_organized\_collection**

A Hierarchically\_organized\_collection is a type of Plant\_item\_collection (see 4.2.262) that indicates whether a Plant\_item (see 4.2.260) that is a member of an aggregate Plant\_item is related to other Plant\_items that are also members of the aggregate Plant\_item. The members of the aggregate may, but need not, be connected.

#### **4.2.142. Hvac\_access\_opening**

## **ISO/CD 10303-227**

An `Hvac_access_opening` is a hole in an `Hvac_component` (see **4.2.145**) providing maintenance access.

The data associated with an `Hvac_access_opening` are the following:

- `access_opening_id`;
- `access_type`;
- `shape`.

### **4.2.142.1 access\_opening\_id**

This attribute differentiates one `Hvac_access_opening` on an `Hvac_component` (see **4.2.145**) from another.

### **4.2.142.2 access\_type**

This attribute specifies the type of opening in the `Hvac_component` (see **4.2.145**).

### **4.2.142.3 shape**

The `shape` is the volumetric representation of the `Hvac_access_opening` or the projection of the `Hvac_access_opening` on the `Hvac_component` (see **4.2.145**).

## **4.2.143. Hvac\_bend**

An `Hvac_bend` is an `Hvac_fitting` (see **4.2.157**) which follows a curved path. The cross section of the fitting is normal to the path.

The data associated with an `Hvac_bend` are the following:

- `bend_path`;
- `end_1_connector`;
- `end_2_connector`;
- `length`.

### **4.2.143.1 bend\_path**

The `bend_path` is the centreline trace of the `Hvac_bend`.

### **4.2.143.2 end\_1\_connector**

The `end_1_connector` is the primary connecting end of an `Hvac_bend`.

### **4.2.143.3 end\_2\_connector**

The end\_2\_connector is the secondary connecting end of an Hvac\_bend.

#### 4.2.143.4 length

The length refers to the extent of the Hvac\_bend from beginning to end.

#### 4.2.144. Hvac\_branch\_connection

An Hvac\_branch\_connection is a connection between the logical termination of one Hvac\_section\_segment (see 4.2.169) and a point on another Hvac\_section segment other than a termination.

The data associated with an Hvac\_branch\_connection are the following:

— branch\_sequence\_id.

This attribute specifies an alphanumeric identifier that indicates the order that branches extend from the main Hvac\_section\_segment (see 4.2.169).

NOTE All branch\_sequence\_ids are unique with respect to the branches of a given Hvac\_section\_segment (see 4.2.169).

#### 4.2.145. Hvac\_component

An Hvac\_component is a type of Plant\_item (see 4.2.260) that is an individually identifiable item or combination of items that is part of an Hvac\_system (see 4.2.176). Each Hvac\_component may be one of the following: an Hvac\_equipment (see 4.2.156), an Hvac\_fitting (see 4.2.157), an Hvac\_ducting (see 4.2.151), and Hvac\_instrument (see 4.2.160), and an Hvac\_flow\_control\_device (see 4.2.158).

EXAMPLE The description attribute inherited from Plant\_item (see 4.2.260) is used to describe the Hvac\_component. Examples to descriptions include "air handling unit", "chiller", or "space heater".

An Hvac\_component applies to any element that is a subset member of an Hvac\_system (see 4.2.176).

The data associated with an Hvac\_component are the following:

— design\_flow\_rate;

— design\_flow\_condition;

— design\_pressure;

— design\_temperature;

— pressure\_loss\_coefficient;

— pressure\_drop;

— velocity.

##### 4.2.145.1 design\_flow\_rate

## **ISO/CD 10303-227**

This attribute specifies the required flow volume over a specific unit of time.

### **4.2.145.2 design\_flow\_condition**

This attribute defines the flow volume under standard operating procedures.

### **4.2.145.3 design\_pressure**

This attribute specifies the maximum allowable pressure at the Hvac\_connector (see **4.2.147**). It may be specified as a single value or as a range of values.

NOTE 1 This value is normally created as part of doing 3D analysis of the Hvac\_system (see **4.2.176**) design.

NOTE 2 See annex L for a discussion of attributes that may be assigned a single value or a range of values.

### **4.2.145.4 design\_temperature**

This attribute specifies the maximum allowable temperature at the Hvac\_connector (see **4.2.147**). It may be specified as a single value or as a range of values.

NOTE 1 This value is normally created as part of doing 3D analysis of the Hvac\_system (see **4.2.176**) design.

NOTE 2 See annex L for a discussion of attributes that may be assigned a single value or a range of values.

### **4.2.145.5 pressure\_loss\_coefficient**

This attribute specifies a mathematical expression applied to the Hvac\_system (see **4.2.176**) pressure to indicate loss to the system air flow due to internal system factors such as friction and turbulence.

### **4.2.145.6 pressure\_drop**

This attribute specifies the loss of air flow due to leaks, friction, or distance.

### **4.2.145.7 velocity**

This attribute specifies the distance which air moves per unit of time, usually in feet per minute or feet per second.

## **4.2.146. Hvac\_component\_thickness**

An Hvac\_component\_thickness is the skin thickness of the Hvac\_component (see **4.2.145**).

The data associated with an Hvac\_component\_thickness are the following:

- sheet\_metal\_thickness;
- thickness\_type.

### **4.2.146.1 sheet\_metal\_thickness**

This attribute specifies the dimension between two of the sheet metals opposite surfaces. The thickness specifies the perpendicular distance between the two faces of the sheet metal. It may be specified as a single value or as a range of values.

NOTE See Annex L for a discussion of attributes that may be assigned a single value or a range of values.

#### **4.2.146.2 thickness\_type**

This attribute specifies the specific unit measurement type applied to quantify the thickness for a given element of an Hvac\_system (see 4.2.176).

#### **4.2.147. Hvac\_connector**

An Hvac\_connector is a type of Plant\_item\_connector (see 4.2.265) that is intended to establish a material flow connection between two Plant\_item (see 4.2.260) objects. within an Hvac\_system (see 4.2.176).

The data associated with an Hvac\_connector are the following:

- name;
- hvac\_connector\_specification;
- hvac\_joint\_inspection\_specification;
- connector\_flow\_direction;
- hvac\_joint\_test\_specification;
- hvac\_joint\_engagement\_length;
- hvac\_joint\_joining\_type;
- hvac\_joint\_sealant\_type;
- hvac\_joint\_joint\_type;
- hvac\_joint\_tightness.

##### **4.2.147.1 name**

This attribute specifies a textual label given to the Hvac\_connector.

##### **4.2.147.2 hvac\_connector\_specification**

This attribute specifies the specification associated with the Hvac\_connector. There may be more than one hvac\_connector\_specification for an Hvac\_connector.

EXAMPLE Examples of the identified connector\_specification include insulation specification, end preparation specification, and thread specification.

##### **4.2.147.3 hvac\_joint\_inspection\_specification**

This attribute specifies the criteria for the review and approval processes of Hvac\_component (see 4.2.145) connections.

##### **4.2.147.4 connector\_flow\_direction**

This attribute specifies the direction process air moves past the Plant\_item (see 4.2.260). The value of connector\_flow\_direction is one of the following:

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- both
- inlet
- outlet

### **4.2.147.5 hvac\_joint\_test\_specification**

This attribute specifies the test and evaluation procedures which apply to Hvac\_component (see **4.2.145**) connections.

### **4.2.147.6 hvac\_joint\_engagement\_length**

This attribute specifies the length of the interface between joined Hvac\_components (see **4.2.145**).

### **4.2.147.7 hvac\_joint\_joining\_type**

This attribute specifies the method of mechanically joining the Hvac\_components (see **4.2.145**). The value of the hvac\_joint\_joining\_type may be one of the following:

- weld
- solder
- lapped\_rivet
- sheet\_metal\_screw

### **4.2.147.8 hvac\_joint\_sealant\_type**

This attribute specifies the method used to seal the joint in order to satisfy the leak condition specified by the hvac\_joint\_tightness. The value of the hvac\_joint\_sealant\_type may be one of the following:

- hvac\_gasket
- hvac\_thermal\_fit\_band
- hvac\_duct\_sealant
- hvac\_tape

#### **4.2.147.8.1 hvac\_gasket**

The hvac\_gasket is a seal or packing used between components to prevent the escape of air.

#### **4.2.147.8.2 hvac\_thermal\_fit\_band**

The hvac\_thermal\_fit\_band is usually associated with spiral duct work where one piece is slid into another. The thermal\_fit\_band or coupler is placed around the joint and when heated seals the ducts together.

#### **4.2.147.8.3 hvac\_duct\_sealant**

The hvac\_duct\_sealant is an adhesive agent used to secure hvac components to prevent seepage of moisture or air.

#### **4.2.147.8.4 hvac\_tape**

The hvac\_tape provides a seal to the hvac\_joint\_joining\_type

### **4.2.147.9 hvac\_joint\_joint\_type**

This attribute specifies the method used to join Plant\_item\_connection\_occurrence (see **4.2.264**) objects.

**4.2.147.10 hvac\_joint\_tightness**

This attribute specifies the ability of the joint to resist leakage. The value of hvac\_joint\_tightness is one of the following:

- air\_tight
- water\_tight
- non\_water\_tight
- drip\_tight

**4.2.147.10.1 air\_tight**

An air\_tight joint shall not allow any gas to leak through the joint.

**4.2.147.10.2 water\_tight**

A water\_tight joint shall not allow any water to leak through the joint.

**4.2.147.10.3 non\_water\_tight**

Non\_water\_tight refers to an hvac joint description which is not required to prevent or retard the passage of any liquid or air at the designated hvac joint.

**4.2.147.10.4 drip\_tight**

A drip\_tight joint shall not allow any fluid, including air to leak from the joint.

**4.2.148. Hvac\_connector\_service\_characteristic**

An Hvac\_connector\_service\_characteristic defines the operating conditions for which the Hvac\_connector (see **4.2.147**) is designed.

The data associated with an Hvac\_connector\_service\_characteristic are the following:

- design\_pressure;
- design\_temperature.

**4.2.148.1 design\_pressure**

This attribute specifies the maximum allowable pressure at the Hvac\_connector (see **4.2.147**). It may be specified as a single value or as a range of values.

NOTE 1 This value is normally created as part of doing 3D analysis of the Hvac\_system (see **4.2.176**) design.

NOTE 2 See annex L for a discussion of attributes that may be assigned a single value or a range of values.

**4.2.148.2 design\_temperature**

This attribute specifies the maximum allowable temperature at the Hvac\_connector (see **4.2.147**). It may be specified as a single value or as a range of values.

NOTE 1 This value is normally created as part of doing 3D analysis of the Hvac\_system (see **4.2.176**) design.

NOTE 2 See annex L for a discussion of attributes that may be assigned a single value or a range of values.

### 4.2.149. Hvac\_coupling

An Hvac\_coupling is a type of Hvac\_fitting (see **4.2.157**) which makes a flexible or rigid connection between two Hvac\_component (see **4.2.145**) objects.

The data associated with an Hvac\_coupling are the following:

- end\_1\_connector;
- end\_2\_connector;
- length;
- offset\_x;
- offset\_y.

#### 4.2.149.1 end\_1\_connector

This attribute is the primary connecting end of an Hvac\_coupling.

#### 4.2.149.2 end\_2\_connector

This attribute is the secondary connecting end of an Hvac\_coupling.

#### 4.2.149.3 length

This attribute is the distance of the Hvac\_coupling from beginning to end.

#### 4.2.149.4 offset\_x

This attribute specifies the distance between end\_connector\_1 and end\_connector\_2 as measured along the x axis of the Hvac\_cross\_section (see **4.2.150**).

#### 4.2.149.5 offset\_y

This attribute specifies the distance between end\_connector\_1 and end\_connector\_2 as measured along the y axis of the Hvac\_cross\_section (see **4.2.150**).

### 4.2.150. Hvac\_cross\_section

An Hvac\_cross\_section is a planar shape created by a plane cutting through an Hvac\_component (see **4.2.145**) at a right angle to the components centreline axis. This reveals the external outline of the component. Each Hvac\_cross\_section may be one of the following: a Cross\_section\_flat\_oval (see **4.2.78**), a Cross\_section\_non\_standard (see **4.2.79**), a Cross\_section\_radiused\_corner (see **4.2.80**), a Cross\_section\_rectangular (see **4.2.81**), a Cross\_section\_round (see **4.2.82**), and a Cross\_section\_triangular (see **4.2.83**).

The data associated with an `Hvac_cross_section` are the following:

— `equivalent_length` .

The term `equivalent_length` with respect to the `Hvac_cross_section` means both width and height dimensions are the same.

### **4.2.151.     `Hvac_ducting`**

An `Hvac_ducting` is a type of `Ducting_component` (see **4.2.90**) and a type of `Hvac_component` (see **4.2.145**) that is an individually identifiable piece or section of ducting that is part of an `Hvac_system` (see **4.2.176**). The `hvac_specification_id` is a designation that differentiates one `Hvac_specification` (see **4.2.175**) from another.

The data associated with an `Hvac_ducting` are the following:

— `duct_path`;

— `duct_seam`;

— `length`;

— `end_1_connector`;

— `end_2_connector`.

#### **4.2.151.1 `duct_path`**

This attribute is the centreline trace of the `Hvac_ducting`.

#### **4.2.151.2 `duct_seam`**

This attribute refers to the line formed where two surfaces of the duct overlap each other.

#### **4.2.151.3 `length`**

This attribute is the distance of the `Hvac_ducting` from beginning to end.

#### **4.2.151.4 `end_1_connector`**

The `end_1_connector` is the primary connecting end of a piece of duct.

#### **4.2.151.5 `end_2_connector`**

The `end_2_connector` is the secondary connecting end of a piece of duct.

### **4.2.152.     `Hvac_elbow_90deg_reducing`**

The `Hvac_elbow_90deg_reducing` is a type of `Hvac_fitting` (see **4.2.157**) in which the flow of the air changes direction through a 90 degree turn and the cross section transitions from one size diameter to another.

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In terms of geometric construction, there are two closed curves with an interior trace curve from centre to centre upon which the surface is created.

NOTE 1 In terms of geometric construction, there are two closed curves with an interior trace curve from centre to centre upon which the surface is created.

NOTE 2 Figure 31 depicts an Hvac\_elbow\_90deg\_reducing.

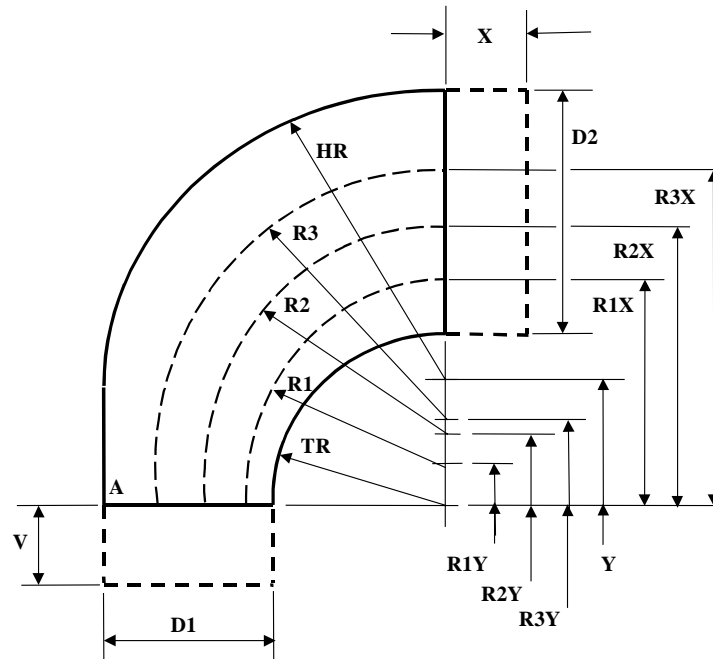


Figure 31 - Hvac\_elbow\_90deg\_reducing

The data associated with an Hvac\_elbow\_90deg\_reducing are the following:

- angle;
- throat\_radius;
- heel\_radius;
- heel\_radius\_centre\_offset;
- end\_1\_connector;
- end\_2\_connector.

### 4.2.152.1 angle

This attribute specifies the sweep angle in degrees for the component elbow.

**4.2.152.2 throat\_radius**

This attribute specifies the inside radius for the component elbow.

**4.2.152.3 heel\_radius**

This attribute specifies the outside radius for the component elbow.

**4.2.152.4 heel\_radius\_centre\_offset**

This attribute specifies the vertical distance from the throat centre to the splitter centre.

**4.2.152.5 end\_1\_connector**

The end\_1\_connector is the primary connecting end of a component elbow.

**4.2.152.6 end\_2\_connector**

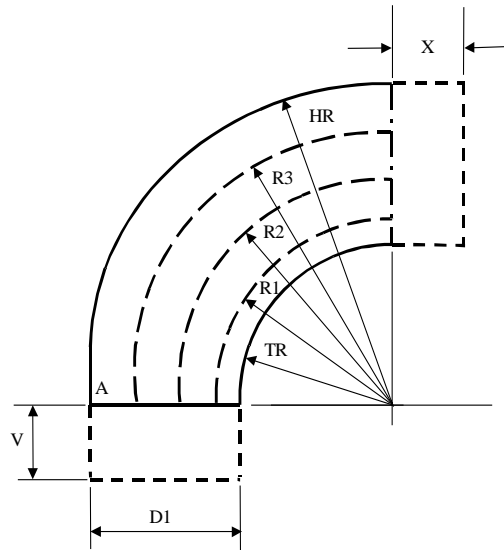
The end\_2\_connector is the secondary connecting end of a component elbow.

**4.2.153. Hvac\_elbow\_centred**

The Hvac\_elbow\_centred is a type of Hvac\_fitting (see **4.2.157**) in which the flow of the air changes direction.

In terms of geometric construction, there are two closed curves with an interior trace curve from centre to centre upon which the surface is created.

NOTE Figure 32 depicts an Hvac\_elbow\_centred.



**Figure 32 - Hvac\_elbow\_centred**

The data associated with an Hvac\_elbow\_centred are the following:

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- angle;
- width;
- height;
- throat\_radius;
- heel\_radius;
- end\_1\_connector;
- end\_2\_connector.

### 4.2.153.1 angle

This attribute specifies the sweep angle in degrees for the component elbow.

### 4.2.153.2 width

This attribute specifies the distance between the sides of the elbow component. Not indicated on the sketch.

### 4.2.153.3 height

This attribute specifies the vertical distance from the throat centre to the heel\_radius.

### 4.2.153.4 throat\_radius

This attribute specifies the inside radius for the component elbow.

### 4.2.153.5 heel\_radius

This attribute specifies the outside radius for the component elbow.

### 4.2.153.6 end\_1\_connector

The end\_1\_connector is the primary connecting end of a component elbow.

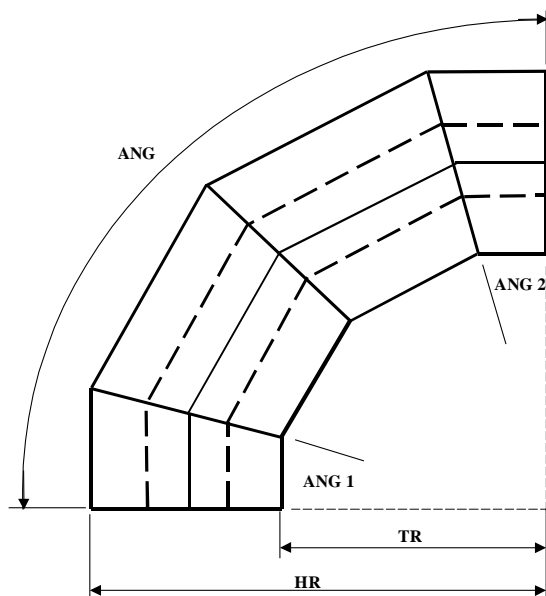
### 4.2.153.7 end\_2\_connector

The end\_2\_connector is the secondary connecting end of a component elbow.

## 4.2.154. Hvac\_elbow\_mitre

An Hvac\_elbow\_mitre is a type of Hvac\_fitting (see **4.2.157**) developed through the use of two or more straight sections of vent that are beveled and joined on a line bisecting the angle of junction.

NOTE Figure 33 depicts an Hvac\_elbow\_mitre.



**Figure 33 - Hvac\_elbow\_mitre**

The data associated with an Hvac\_elbow\_mitre are the following:

- angle\_first\_section;
- angle\_last\_section;
- number\_of\_sections;
- sweep\_angle;
- throat\_radius;
- heel\_radius;
- end\_1\_connector;
- end\_2\_connector.

#### **4.2.154.1 angle\_first\_section**

This attribute specifies the sweep angle in degrees for the first section of the mitred elbow development.

#### **4.2.154.2 angle\_last\_section**

This attribute specifies the sweep angle in degrees for the last section of the mitred elbow development.

#### **4.2.154.3 number\_of\_sections**

This attribute specifies how many sections are necessary to develop the mitred elbow.

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### **4.2.154.4 sweep\_angle**

This attribute specifies the overall angle of the elbow.

### **4.2.154.5 throat\_radius**

This attribute specifies the inside radius for the component elbow.

### **4.2.154.6 heel\_radius**

This attribute specifies the outside radius for the component elbow.

### **4.2.154.7 end\_1\_connector**

The end\_1\_connector is the primary connecting end of a component elbow.

### **4.2.154.8 end\_2\_connector**

The end\_2\_connector is the secondary connecting end of a component elbow.

## **4.2.155. Hvac\_end\_fitting**

An Hvac\_end\_fitting is a type of Hvac\_fitting (see **4.2.157**) which only connects to one other Hvac\_component (see **4.2.145**).

The data associated with an Hvac\_end\_fitting are the following:

- end\_1\_connector;
- opening\_type.

### **4.2.155.1 end\_1\_connector**

The end\_1\_connector is the primary connecting end of an Hvac\_end\_fitting.

### **4.2.155.2 opening\_type**

This attribute specifies the type of opening at the end of the fitting which does not have a connector.

## **4.2.156. Hvac\_equipment**

An Hvac\_equipment is a type of Hvac\_component (see **4.2.145**) used to develop a functional Hvac\_system (see **4.2.176**).

## **4.2.157. Hvac\_fitting**

An Hvac\_fitting is an individual component of an hvac duct system. Each Hvac\_fitting may be one of the following: Hvac\_coupling (see **4.2.149**), an Hvac\_elbow\_90deg\_reducing (see **4.2.152**), an Hvac\_elbow\_centred (see **4.2.153**), an Hvac\_elbow\_mitre (see **4.2.154**), an Hvac\_end\_fitting (see **4.2.155**), an Hvac\_fitting (see **4.2.157**), an Hvac\_gasket (see **4.2.159**), an Hvac\_offset\_centred (see **4.2.161**), an Hvac\_offset\_ogee\_centred (see **4.2.162**), an Hvac\_takeoff (see **4.2.178**), an Hvac\_transition (see **4.2.179**), and an Hvac\_transition\_slanted (see **4.2.180**).

## **4.2.158. Hvac\_flow\_control\_device**

An `Hvac_flow_control_device` is a type of `Hvac_component` (see **4.2.145**) of the `Hvac_system` (see **4.2.176**) that regulates the airflow based on the inline design conditions and settings.

Note Such devices fall into four categories and include sensors, controllers, controlled devices, and auxiliary devices. Auxiliary devices include relays, transducers, and switches.

The data associated with an `Hvac_flow_control_device` are the following:

- `flow_control_device_id`;
- `control_device_type`;
- `end_1_connector`;
- `end_2_connector`;
- `control_point_units`;
- `control_point_nominal_value`;
- `control_point_min_value`;
- `control_point_max_value`;
- `control_point_set_point_value`.

#### **4.2.158.1 flow\_control\_device\_id**

The `flow_control_device_id` is the unique identifier for each of the inline control devices. These include sensors, controllers, controlled devices, and auxiliary devices. It is the unique id for the `Hvac_flow_control_devices`.

#### **4.2.158.2 control\_device\_type**

This attribute specifies the type of device which controls flow.

#### **4.2.158.3 end\_1\_connector**

The `end_1_connector` is the primary connecting end of an `Hvac_flow_control_device`.

#### **4.2.158.4 end\_2\_connector**

The `end_2_connector` is the secondary connecting end of an `Hvac_flow_control_device`.

#### **4.2.158.5 control\_point\_units**

this attribute specifies the units as pounds per square inch.

#### **4.2.158.6 control\_point\_nominal\_value**

This attribute specifies the average controlled airflow in pounds per square inch (psi).

#### **4.2.158.7 control\_point\_min\_value**

This attribute specifies the minimum controlled airflow in pounds per square inch (psi).

#### **4.2.158.8 control\_point\_max\_value**

This attribute specifies the maximum controlled airflow in pounds per square inch (psi).

#### **4.2.158.9 control\_point\_set\_point\_value**

This attribute specifies the variable value assigned as the primary parameter upon which the Hvac\_system (see **4.2.176**) maintains temperature control.

#### **4.2.159. Hvac\_gasket**

An Hvac\_gasket is a type of Hvac\_component (see **4.2.145**) used between components to prevent the escape of air.

Example An example of an Hvac\_gasket is is a seal or packing.

#### **4.2.160. Hvac\_instrument**

An Hvac\_instrument is a type of Hvac\_fitting (see **4.2.157**) which monitors, measures, indicates, and records the system status.

Note The purpose of the Hvac\_instrument is to provide information to the plant operator for analyzing, troubleshooting, and improving the operation of the Hvac\_system (see **4.2.176**).

The data associated with an Hvac\_instrument are the following:

- instrument\_id;
- units;
- low\_range;
- high\_range;
- type;
- parameter\_measured;
- low\_alarm;
- high\_alarm;
- nameplate\_inscription;
- divisions.

##### **4.2.160.1 instrument\_id**

This attribute specifies the unique identifier for each Hvac\_instrument.

##### **4.2.160.2 units**

This attribute specifies the units recorded by the Hvac\_instrument.

Note The units applied to Hvac\_instruments will vary in accordance with the particular Hvac\_system (see **4.2.176**) function that is monitored.

##### **4.2.160.3 low\_range**

This attribute specifies the low end setting for a particular Hvac\_system (see **4.2.176**) function.

Example Oil pressure gauge.

#### **4.2.160.4 high\_range**

This attribute specifies high end setting for an Hvac\_system (see **4.2.176**) function.

#### **4.2.160.5 type**

This attribute specifies a specific kind of Hvac\_instrument device used to monitor an Hvac\_system (see **4.2.176**).

#### **4.2.160.6 parameter\_measure**

This attribute specifies a function that is monitored or measured.

Example Voltage, current, pressure, velocity.

#### **4.2.160.7 low\_alarm**

This attribute specifies a function of an Hvac\_instrument device.

#### **4.2.160.8 high\_alarm**

This attribute specifies a function of an Hvac\_instrument device.

#### **4.2.160.9 nameplate\_inscription**

This attribute specifies the text on the nameplate used to identify an Hvac\_instrument (see **4.2.160**) and the function it is designed to carry out.

#### **4.2.160.10 divisions**

This attribute specifies the gradations on the gauge.

### **4.2.161. Hvac\_offset\_centred**

An Hvac\_offset\_centred is a type of Hvac\_connector (see **4.2.147**) fitting.

The data associated with an Hvac\_offset\_centred are the following:

- angle;
- offset;
- length;
- throat\_radius;
- heel\_radius;
- end\_1\_connector;
- end\_2\_connector.

#### **4.2.161.1 angle**

This attribute specifies the number of degrees for the radial sections at both top and bottom.

#### **4.2.161.2 offset**

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This attribute specifies the perpendicular distance between the centres of two Hvac\_components (see 4.2.145) which are to be connected.

### 4.2.161.3 length

This attribute specifies the horizontal distance between two Hvac\_component (see 4.2.145) objects from connection point one to connection point two.

### 4.2.161.4 throat\_radius

This attribute specifies the inside radius for the end sections of the Hvac\_offset\_centred fitting.

### 4.2.161.5 heel\_radius

This attribute specifies the outside radius for the end sections of the Hvac\_offset\_centred fitting.

### 4.2.161.6 end\_1\_connector

The end\_1\_connector is the primary connecting end of an Hvac\_offset\_centred fitting.

### 4.2.161.7 end\_2\_connector

The end\_2\_connector is the secondary connecting end of an Hvac\_offset\_centred fitting.

## 4.2.162. Hvac\_offset\_ogee\_centred

An Hvac\_offset\_ogee\_centred is a type of Hvac\_fitting (see 4.2.157) that appears to be an “s” shaped component.

NOTE Figure 34 depicts an Hvac\_offset\_ogee\_centred.

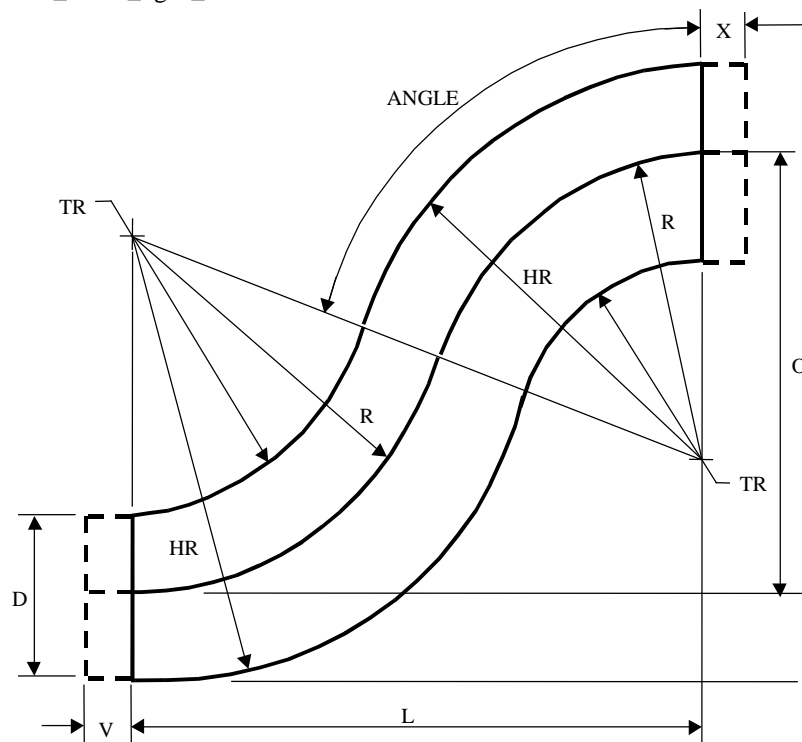


Figure 34 - Hvac\_offset\_ogee\_centred

The data associated with an Hvac\_offset\_ogee\_centred are the following:

- angle;
- offset;
- length;
- throat\_radius;
- heel\_radius;
- end\_1\_connector;
- end\_2\_connector.

#### **4.2.162.1 angle**

This attribute specifies the number of degrees applied to the upper and lower heel and throat radius construction.

#### **4.2.162.2 offset**

This attribute specifies the perpendicular distance between the centrelines of the upper and lower connecting ends of the `Hvac_offset_ogee_centred` component.

#### **4.2.162.3 length**

This attribute specifies the horizontal distance between `end_1_connector` and `end_2_connector` of the `Hvac_offset_ogee_centred` fitting.

#### **4.2.162.4 throat\_radius**

This attribute specifies the interior radius of the radial transition of the `Hvac_offset_ogee_centred`. It applies to the upper and lower transitions.

#### **4.2.162.5 heel\_radius**

This attribute specifies the exterior radius of the radial transition of the `Hvac_offset_ogee_centred`. It applies to the upper and lower transition.

#### **4.2.162.6 end\_1\_connector**

The `end_1_connector` is the primary connecting end of an `Hvac_offset_ogee_centred`.

#### **4.2.162.7 end\_2\_connector**

The `end_2_connector` is the secondary connecting end of an `Hvac_offset_ogee_centred`.

### **4.2.163. Hvac\_plant\_item\_branch\_connection**

An `Hvac_plant_item_branch_connection` is a connection between an `Hvac_plant_item_branch_connection` and a point on an `Hvac_section_segment` (see **4.2.169**) other than an `Hvac_section_segment_terminator` (see **4.2.171**). Each `Hvac_plant_item_branch_connection` defines the branches of exactly one `Hvac_section_segment` (see **4.2.169**).

The data associated with an `Hvac_plant_item_branch_connection` are the following:

- `branch_sequence_id`.

The `branch_sequence_id` specifies an alphanumeric identifier that indicates the order that branches extend from the main `Hvac_section_segment` (see **4.2.169**).

NOTE All `branch_sequence_ids` are unique with respect to the branches of a given `Hvac_section_segment` (see **4.2.169**).

#### **4.2.164. Hvac\_plant\_item\_branch\_connector**

An `Hvac_plant_item_branch_connector` is a type of `Functional_connector` (see **4.2.128**) which connects an `Hvac_plant_item_branch_connector` to a point on an `Hvac_section_segment` (see **4.2.169**) other than a termination. The `Hvac_plant_item_branch_connector` branches from the `Hvac_section_segment`.

#### **4.2.165. Hvac\_plant\_item\_connection**

An `Hvac_plant_item_connection` is a linkage between two or more `Hvac_plant_item_connector` (see **4.2.166**) objects. The joining conditions may be specified for the connection.

#### **4.2.166. Hvac\_plant\_item\_connector**

An `Hvac_plant_item_connector` is a type of `Functional_connector` (see **4.2.128**) which is a feature of a `Plant_item` (see **4.2.260**) that is designed to connect to a connector on another `hvac Plant_item`.

#### **4.2.167. Hvac\_plant\_item\_termination**

An `Hvac_plant_item_termination` is a type of `Hvac_section_segment_termination` (see **4.2.171**) that connects to an `Hvac_plant_item_connection` (see **4.2.165**).

#### **4.2.168. Hvac\_section\_branch\_termination**

An `Hvac_section_branch_termination` is a type of `Hvac_section_segment_termination` (see **4.2.171**) that connects to an `Hvac_section_segment` (see **4.2.169**) at a point other than a termination.

#### **4.2.169. Hvac\_section\_segment**

An `Hvac_section_segment` is an element of an `Hvac_system_section` (see **4.2.177**) which terminates at a functional `Plant_item_connector` (see **4.2.265**), a tap into an `Hvac_system_section`, or a point where the stream diverges or converges.

The data associated with an `Hvac_section_segment` are the following:

- `hvac_segment_id`;
- `pressure_drop`.

##### **4.2.169.1 hvac\_segment\_id**

This attribute specifies a unique identifier for the `Hvac_section_segment`.

##### **4.2.169.2 pressure\_drop**

This attribute specifies the drop in pressure in the `Hvac_section_segment`.

**4.2.170. Hvac\_section\_segment\_insulation**

An Hvac\_section\_segment\_insulation is a piece of insulation which is applied uniformly to the Hvac\_section\_segment (see 4.2.169).

The data associated with an Hvac\_section\_segment\_insulation are the following:

- insulation\_thickness;
- insulation\_type;
- insulation\_description;
- insulation\_specification.

**4.2.170.1 insulation\_thickness**

This attribute specifies the total thickness of the insulation measure from the surface of the Hvac\_section\_segment (see 4.2.169) outward.

**4.2.170.2 insulation\_type**

This attribute specifies the type of material which keeps the hot side hot and the cold side cold.

**4.2.170.3 insulation\_description**

This attribute specifies a description of the insulation.

**4.2.170.4 insulation\_specification**

This attribute specifies a document which describes the properties of the insulation.

**4.2.171. Hvac\_section\_segment\_termination**

An Hvac\_section\_segment\_termination is one of the logical end-points of an Hvac\_section\_segment (see 4.2.169). Each Hvac\_section\_segment\_termination may be one of the following: an Hvac\_section\_branch\_termination (see 4.2.168), an Hvac\_section\_termination (see 4.2.172), an Hvac\_section\_to\_section\_termination (see 4.2.174), and an Hvac\_plant\_item\_termination (see 4.2.167).

The data associated with an Hvac\_section\_segment\_termination are the following:

- flow\_direction.

The flow\_direction is the direction of flow of the fluid with respect to the Hvac\_section\_segment (see 4.2.169).

**4.2.172. Hvac\_section\_termination**

An Hvac\_section\_termination is a type of Hvac\_section\_segment\_termination (see 4.2.171) that begins or ends an Hvac\_section\_segment (see 4.2.169).

The data associated with an Hvac\_section\_termination are the following:

- location;
- start\_or\_end.

**4.2.172.1 location**

This attribute specifies the relative distance in the X, Y, Z directions of the position of the end of the Hvac\_section\_segment (see **4.2.169**), from the plant origin.

NOTE The location position may also be defined by where it connects to an upstream piece of Equipment (see **4.2.104**) or Hvac\_section\_segment.

**4.2.172.2 start\_or\_end**

This attribute specifies an enumerated value that defines the side of the Hvac\_ducting (see **4.2.151**) on which the section termination lies.

NOTE A value of 'start' indicates the section termination is on the upstream end, and a value of 'end' indicates that the section termination is on the downstream end.

**4.2.173. Hvac\_section\_to\_section\_connection**

An Hvac\_section\_to\_section\_connection is a connection between two Hvac\_section\_segments (see **4.2.169**) .

The data associated with an Hvac\_section\_to\_section\_connection are the following:

— section\_to\_section\_connection\_id.

The section\_to\_section\_connection\_id is a unique identifier of the connection between two Hvac\_section\_segments (see **4.2.169**).

**4.2.174. Hvac\_section\_to\_section\_termination**

An Hvac\_section\_to\_section\_termination is the terminating segment of an Hvac\_section\_segment (see **4.2.169**) which is the terminating segment of an Hvac\_section\_segment (see **4.2.169**).

**4.2.175. Hvac\_specification**

The data associated with an Hvac\_specification are the following:

— hvac\_specification\_id;

— name;

— owner;

— service\_description.

**4.2.175.1 hvac\_specification\_id**

This attribute specifies a designation that differentiates one Hvac\_specification from another.

**4.2.175.2 name**

This attribute specifies a textual label given to the Hvac\_specification.

**4.2.175.3 owner**

This attribute specifies the owner as a point of contact for the specification.

**4.2.175.4 service\_description**

This attribute specifies the service that this specification applies to.

**4.2.176. Hvac\_system**

An Hvac\_system is a type of Ducting\_system (see **4.2.91**) that controls the temperature, humidity, cleanliness, and circulation of environmental air as required in a Building (see **4.2.14**).

**4.2.177. Hvac\_system\_section**

An Hvac\_system\_section consists of one or many Hvac\_section\_segments (see **4.2.169**).

The data associated with an Hvac\_system\_section are the following:

— hvac\_section\_id;

The hvac\_section\_id specifies a unique identifier for the Hvac\_section\_segment (see **4.2.169**).

**4.2.178. Hvac\_takeoff**

An Hvac\_takeoff is a type of Hvac\_fitting (see **4.2.157**) which has three end connectors.

The data associated with an Hvac\_takeoff are the following:

— end\_1\_connector;

— end\_2\_connector;

— end\_3\_connector;

— centre\_to\_end\_1\_length;

— centre\_to\_end\_2\_length;

— centre\_to\_end\_3\_length;

— takeoff\_angle.

**4.2.178.1 end\_1\_connector**

The end\_1\_connector is the connector to the inlet of the Hvac\_takeoff.

**4.2.178.2 end\_2\_connector**

The end\_2\_connector is the connector to the outlet of the Hvac\_takeoff.

**4.2.178.3 end\_3\_connector**

The end\_3\_connector is the connector to the branch of the Hvac\_takeoff.

**4.2.178.4 centre\_to\_end\_1\_length**

This attribute specifies the distance from the intersection of the branch and the run to end\_1\_connector which is the inlet of the Hvac-fitting (see **4.2.157**).

**4.2.178.5 centre\_to\_end\_2\_length**

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This attribute specifies the distance from the intersection of the branch and the run to end\_2\_connector which is the outlet of the Hvac\_fitting (see 4.2.157).

### 4.2.178.6 centre\_to\_end\_3\_length

This attribute specifies the distance from the intersection of the branch and the run to end\_3\_connector which is the branch of the Hvac\_fitting (see 4.2.157).

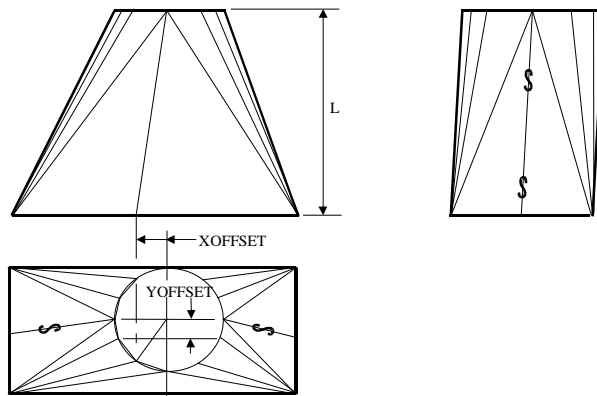
### 4.2.178.7 takeoff\_angle

This attribute specifies the angle between the through run of the Hvac\_fitting (see 4.2.157) and the line segment connecting the intersection of the branch and the run to the termination to the end\_3\_connector.

## 4.2.179. Hvac\_transition

An Hvac\_transition is a type of Hvac\_fitting (see 4.2.157) between two Hvac\_section\_segments (see 4.2.169) having different cross sections, shapes, size, or having an offset.

NOTE Figure 35 depicts an Hvac\_transition from Rectangular to Round



**Figure 35 - Transition - Rectangular to Round**

The data associated with an Hvac\_transition are the following:

- offset\_x;
- offset\_y;
- length;
- end\_1\_connector;
- end\_2\_connector.

### 4.2.179.1 offset\_x

This attribute specifies the distance from the inlet to the outlet as shown by XOFFSET in Figure 35

**4.2.179.2 offset\_y**

This attribute specifies the distance from the inlet to the outlet as shown by YOFFSET in Figure 35

**4.2.179.3 length**

This attribute specifies the length of the transition as shown by L in Figure 35.

**4.2.179.4 end\_1\_connector**

The end\_1\_connector is the primary connecting end of a transition.

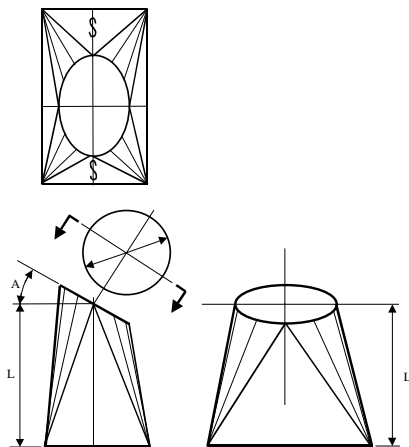
**4.2.179.5 end\_2\_connector**

The end\_2\_connector is the secondary connecting end of a transition.

**4.2.180. Hvac\_transition\_slanted**

An Hvac\_transition\_slanted is a type of Hvac\_fitting (see **4.2.157**) which provides a change in size and a change in direction between two Plant\_items (see **4.2.260**).

NOTE Figure 36 depicts an Hvac\_transition\_slanted from Rectangle to Round



**Figure 36 - Transition - Rectangle to Round Slanted**

The data associated with an Hvac\_transition\_slanted are the following:

- slant\_angle;
- length;
- end\_1\_connector;
- end\_2\_connector.

**4.2.180.1 slant\_angle**

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This attribute specifies the slant angle of the transition as shown by A in Figure 36.

### **4.2.180.2 length**

This attribute specifies the length between end\_1\_connector and end\_2\_connector.

### **4.2.180.3 end\_1\_connector**

The end\_1\_connector is the primary connecting end of a slanted transition.

### **4.2.180.4 end\_2\_connector**

The end\_2\_connector is the secondary connecting end of a slanted transition.

## **4.2.181. Hybrid\_shape\_representation**

A Hybrid\_shape\_representation is a type of Shape\_representation. (see **4.2.309**).

## **4.2.182. Inline\_equipment**

An Inline\_equipment is a type of Equipment (see **4.2.104**) and Piping\_system\_component (see **4.2.250**) that is inserted into the flow of a process stream to perform a function.

## **4.2.183. Inline\_instrument**

An Inline\_instrument is a type of Instrument (see **4.2.188**) and Piping\_system\_component (see **4.2.250**) that is inserted into the flow of a process stream to measure some characteristic of the stream.

EXAMPLE Thermowells, pressure gauges, and flowmeters are examples of Inline\_instruments.

The data associated with an Inline\_instrument are the following:

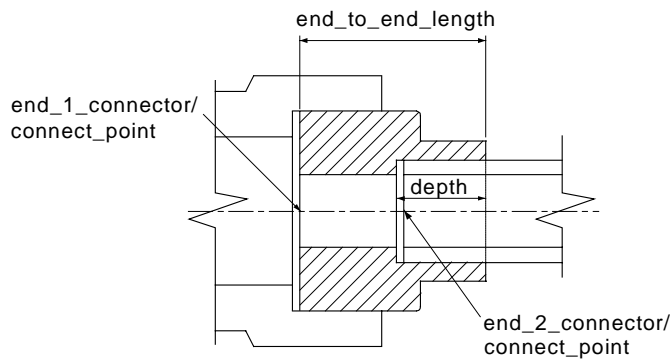
— control\_loop\_id.

A control\_loop\_id specifies a unique identifier for a control module that is implemented by an Inline\_instrument.

## **4.2.184. Insert**

An Insert is a type of Fitting (see **4.2.118**) with one external and one smaller internal end.

NOTE Figure 37 depicts a typical Insert.



**Figure 37 - Insert**

The data associated with an Insert are the following:

- end\_1\_connector;
- end\_2\_connector;
- end\_to\_end\_length.

#### **4.2.184.1 end\_1\_connector**

The end\_1\_connector specifies the Piping\_connector (see 4.2.242) designated as Male\_end (see 4.2.215).

#### **4.2.184.2 end\_2\_connector**

The end\_2\_connector specifies the Piping\_connector (see 4.2.242) designated as Female\_end (see 4.2.116).

#### **4.2.184.3 end\_to\_end\_length**

The end\_to\_end\_length specifies the external length of the Insert from the end-one face to the end-two face. It may be specified as a single value or as a range of values.

NOTE See annex L for a discussion of attributes that may be assigned a single value or a range of values.

### **4.2.185. Inside\_and\_thickness**

An Inside\_and\_thickness is a type of Piping\_size\_description (see 4.2.244) that describes the size of a Piping\_system\_component (see 4.2.250) or a Piping\_connector (see 4.2.242) using an actual (intended) inside diameter and wall thickness.

The data associated with an Inside\_and\_thickness are the following:

- inside\_diameter;
- thickness.

#### **4.2.185.1 inside\_diameter**

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The `inside_diameter` specifies the actual (intended, not nominal) inside diameter of the `Piping_system_component` (see **4.2.250**) or `Piping_connector` (see **4.2.242**). It may be specified as a single value or as a range of values.

NOTE See annex L for a discussion of attributes that may be assigned a single value or a range of values.

### **4.2.185.2 thickness**

The `thickness` specifies the minimum distance between the inside and outside piping wall surfaces required for the `Piping_system_component` (see **4.2.250**) or `Piping_connector` (see **4.2.242**). It may be specified as a single value or as a range of values.

NOTE See annex L for a discussion of attributes that may be assigned a single value or a range of values.

## **4.2.186. Inspection\_condition**

The `Inspection_condition` is a characteristic which shall be required to be attained for the inspection to be accomplished.

The data associated with an `Inspection_condition` are the following:

— `condition_name`;

— `value`.

### **4.2.186.1 condition\_name**

The `condition_name` specifies the characteristic that is being defined.

EXAMPLE “welding preheating temp” and “post heating temp” are inspection condition names.

### **4.2.186.2 value**

The `value` specifies the specific quantity or alphanumeric qualifier for the characteristic that affects the inspection.

## **4.2.187. Installed\_physical\_design\_view**

An `Installed_physical_design_view` is an indication that the `Plant_item` (see **4.2.260**) described by a `Physical_design_view` (see **4.2.235**) is physically installed within the `Plant` (see **4.2.258**).

NOTE Within a usage of this part of ISO 10303, all `Plant_items` (see **4.2.260**) are considered as planned physical design views unless they are related to `Installed_physical_design_view`. This relationship indicates that the `Plant_item` is an actual item that currently exists or is installed in the `Plant` (see **4.2.258**).

The data associated with an `Installed_physical_design_view` are the following:

— `serial_number`.

The `serial_number` specifies a designation that uniquely identifies a particular physical `Plant_item` (see **4.2.260**) that is installed in a `Plant` (see **4.2.258**).

NOTE The designation is typically assigned and affixed by the manufacturer of the Plant\_item (see 4.2.260).

## 4.2.188. Instrument

An Instrument is a type of Instrumentation\_and\_control\_component (see 4.2.189) that monitors one or more performance characteristics of a system. Each Instrument may be one of the following: an Inline\_instrument (see 4.2.183) or an Offline\_instrument (see 4.2.224).

The data associated with an Instrument are the following:

- instrument\_type;
- sensor\_type;
- signal\_type;
- stream\_interaction\_type.

### 4.2.188.1 instrument\_type

The instrument\_type specifies a classification of an Instrument based on its performance characteristics.

EXAMPLE Examples of instrument\_type classifications include flow control, level control, pressure, or temperature.

### 4.2.188.2 sensor\_type

The sensor\_type specifies a classification of an Instrument actuator based on its operational characteristics.

### 4.2.188.3 signal\_type

The signal\_type specifies a classification of an Instrument signal based on its physical characteristics.

EXAMPLE Examples of instrument signal\_type classifications include electric and pneumatic.

### 4.2.188.4 stream\_interaction\_type

The stream\_interaction\_type specifies a classification of an Instrument based on how the sensor is positioned to sense the stream.

EXAMPLE Examples of stream\_interaction\_types include outside, inserted, and immersed.

## 4.2.189. Instrumentation\_and\_control\_component

An Instrumentation\_and\_control\_component is a type of Plant\_item (see 4.2.260) that is an individually identifiable item or combination of items that is part of the Instrumentation\_and\_control\_system (see 4.2.190). Each Instrumentation\_and\_control\_component may be an Instrument (see 4.2.188).

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EXAMPLE Examples of Instrumentation\_and\_control\_component objects include wiring, switches, control valves, and gauges.

### **4.2.190. Instrumentation\_and\_control\_system**

An Instrumentation\_and\_control\_system is a type of Plant\_system (see **4.2.276**) that is a system of wiring, switches, controls, and other equipment associated with monitoring and controlling the performance characteristics of Plant\_system objects.

The data associated with an Instrumentation\_and\_control\_system are the following:

— type.

The type specifies a designation that classifies the Instrumentation\_and\_control\_system based on the kind of service that it provides.

### **4.2.191. Insulation**

An Insulation is a type of Plant\_item (see **4.2.260**) that is a material or assembly of materials used to provide resistance to heat flow.

### **4.2.192. Interfering\_shape\_element**

An Interfering\_shape\_element is the portion of the Plant\_item\_shape (see **4.2.273**) that is interfered with by a shape element of another Plant\_item (see **4.2.260**).

NOTE This application object is intended to support design integration, specifically the need to identify the elements of the designs that physically interfere with one another.

The data associated with an Interfering\_shape\_element are the following:

— first\_item;

— interference\_colour;

— second\_item.

#### **4.2.192.1 first\_item**

The first\_item specifies the plant\_item\_id of one of the Plant\_items (see **4.2.260**) that is interfering.

#### **4.2.192.2 interference\_colour**

The interference\_colour specifies the colour that displays the element.

#### **4.2.192.3 second\_item**

The second\_item specifies the plant\_item\_id of one of the Plant\_items (see **4.2.260**) that is interfering.

### 4.2.193. Lap\_joint\_flange

A Lap\_joint\_flange is a type of Flange (see 4.2.119) that has a rounded contour at the intersection of the bore and the Flange face in order to mate to a Lap\_joint\_stub\_end (see 4.2.194).

NOTE 1 This Flange (see 4.2.119) can be swiveled around a Lap\_joint\_stub\_end (see 4.2.194) in order to align bolt holes.

NOTE 2 Figure 38 depicts a typical Lap\_joint\_flange.

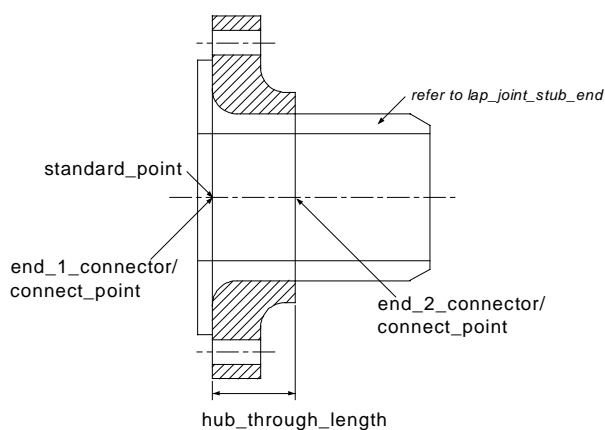


Figure 38 - Lap\_joint\_flange

### 4.2.194. Lap\_joint\_stub\_end

A Lap\_joint\_stub\_end is a type of Fitting (see 4.2.118) used with a Lap\_joint\_flange (see 4.2.193), consisting of a cylinder or barrel with an integral flat ring or lap around one end with a rounded contour at the external intersection of the barrel and the lap.

NOTE 1 Figure 39 depicts a typical Lap\_joint\_stub\_end.

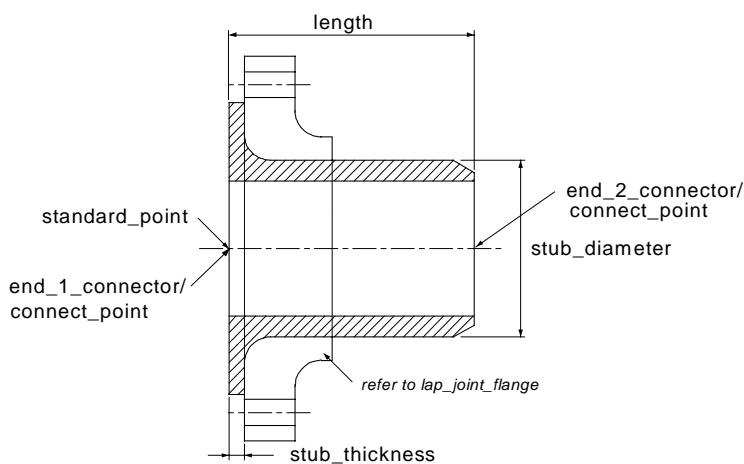


Figure 39 - Lap\_joint\_stub\_end

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NOTE 2 End two is beveled for butt welding to pipe. The lap face normally has a flat or concentric serrated finish. This surface serves as the raised-face gasket surface of the Flange (see **4.2.119**) in Lap\_joint\_flange (see **4.2.193**) connections.

The data associated with a Lap\_joint\_stub\_end are the following:

- end\_1\_connector;
- end\_2\_connector;
- length;
- stub\_diameter;
- stub\_thickness.

### **4.2.194.1 end\_1\_connector**

The end\_1\_connector specifies the Piping\_connector (see **4.2.242**) at the stub end face that connects to another Flange (see **4.2.119**) or Nozzle (see **4.2.222**).

### **4.2.194.2 end\_2\_connector**

The end\_2\_connector specifies the Piping\_connector (see **4.2.242**) at the stub end face that connects to a non-flange Piping\_component (see **4.2.240**).

### **4.2.194.3 length**

The length specifies the external distance between the lap face and the other stub end face. It may be specified as a single value or as a range of values.

NOTE See annex L for a discussion of attributes that may be assigned a single value or a range of values.

### **4.2.194.4 stub\_diameter**

The stub\_diameter specifies the nominal diameter of the Lap\_joint\_stub\_end. It may be specified as a single value or as a range of values.

NOTE See annex L for a discussion of attributes that may be assigned a single value or a range of values.

### **4.2.194.5 stub\_thickness**

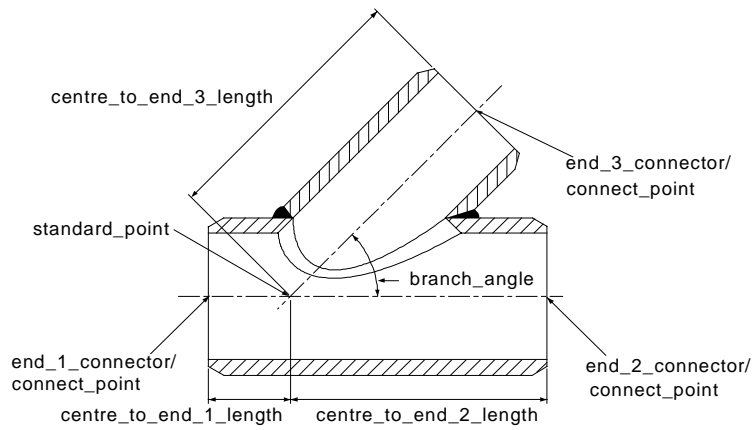
The stub\_thickness specifies the distance between the inner and outer surfaces of the flared portion of the stub end. It may be specified as a single value or as a range of values.

NOTE See annex L for a discussion of attributes that may be assigned a single value or a range of values.

## **4.2.195. Lateral**

A Lateral is a type of Fitting (see **4.2.118**) that is a three-way fitting having two ends opposite each other in a straight run and a branch outlet projecting from the run at an angle.

NOTE Figure 40 depicts a typical butt-weld Lateral.



**Figure 40 - Lateral**

The data associated with a Lateral are the following:

- `branch_angle`;
- `centre_to_end_1_length`;
- `centre_to_end_2_length`;
- `centre_to_end_3_length`;
- `end_1_connector`;
- `end_2_connector`;
- `end_3_connector`.

#### **4.2.195.1 `branch_angle`**

The `branch_angle` specifies the angle that the branch projects from the straight run. It may be specified as a single value or as a range of values.

NOTE See annex L for a discussion of attributes that may be assigned a single value or a range of values.

#### **4.2.195.2 `centre_to_end_1_length`**

The `centre_to_end_1_length` specifies the distance between the point where the branch and straight run centrelines intersect and the straight-run face that is closest to the intersection. It may be specified as a single value or as a range of values.

NOTE See annex L for a discussion of attributes that may be assigned a single value or a range of values.

#### **4.2.195.3 `centre_to_end_2_length`**

The `centre_to_end_2_length` specifies the distance between the point where the branch and straight run centrelines intersect and the straight-run face that is furthest from the intersection. It may be specified as a single value or as a range of values.

NOTE See annex L for a discussion of attributes that may be assigned a single value or a range of values.

**4.2.195.4 centre\_to\_end\_3\_length**

The `centre_to_end_3_length` specifies the distance between the point where the branch and straight run centrelines intersect and the branch face. It may be specified as a single value or as a range of values.

NOTE See annex L for a discussion of attributes that may be assigned a single value or a range of values.

**4.2.195.5 end\_1\_connector**

The `end_1_connector` specifies the `Piping_connector` (see **4.2.242**) on the straight run that is closest to the intersection between the centrelines of the branch run and straight run.

**4.2.195.6 end\_2\_connector**

The `end_2_connector` specifies the `Piping_connector` (see **4.2.242**) on the straight run that is furthest from the intersection between the centrelines of the branch run and straight run.

**4.2.195.7 end\_3\_connector**

The `end_3_connector` specifies the `Piping_connector` (see **4.2.242**) that connects to the branch line.

**4.2.196. Line**

A `Line` is a type of `Curve` (see **4.2.85**) that is a one-dimensional, contiguous set of points that are positioned at a constant distance from a vector or that constitute the shortest distance between two points.

**4.2.197. Line\_branch\_connection**

A `Line_branch_connection` is a connection between the logical termination of one `Piping_system_line_segment` (see **4.2.252**) and a point on another `Piping_system_line_segment` other than a termination. The former `Piping_system_line_segment` branches from the latter `Piping_system_line_segment`.

The data associated with a `Line_branch_connection` are the following:

— `line_number`.

The `line_number` specifies an alphanumeric identifier assigned to the `Piping_system_line` (see **4.2.251**) and can be used to uniquely define the `Piping_system_line`. `Line_number` is required for each `Piping_system_line`.

**4.2.198. Line\_branch\_termination**

A `Line_branch_termination` is a type of `Piping_system_line_segment_termination` (see **4.2.253**) that connects to a `Piping_system_line_segment` (see **4.2.252**) at a point other than a termination.

The data associated with a `Line_branch_termination` are the following:

— line\_number.

The line\_number specifies an alphanumeric identifier assigned to the Piping\_system\_line (see 4.2.251) and can be used to uniquely define the Piping\_system\_line. Line\_number is required for each Piping\_system\_line.

#### **4.2.199. Line\_less\_piping\_system**

A Line\_less\_piping\_system is a type of Piping\_system (see 4.2.249) that does not have a line designation as defined in Piping\_system\_line (see 4.2.251).

#### **4.2.200. Line\_piping\_system\_component\_assignment**

A Line\_piping\_system\_component\_assignment is the relationship between a Piping\_system\_line (see 4.2.251) and a Piping\_system\_component (see 4.2.250) that is part of, or satisfies the need specified by, the Piping\_system\_line.

The data associated with a Line\_piping\_system\_component\_assignment are the following:

— line\_number.

The line\_number specifies an alphanumeric identifier assigned to the Piping\_system\_line (see 4.2.251) and can be used to uniquely define the Piping\_system\_line. Line\_number is required for each Piping\_system\_line.

#### **4.2.201. Line\_plant\_item\_branch\_connection**

A Line\_plant\_item\_branch\_connection is a connection between a Line\_plant\_item\_branch\_connector (see 4.2.202) and a point on a Piping\_system\_line\_segment (see 4.2.252) other than a termination. The Line\_plant\_item\_branch\_connector branches from the Piping\_system\_line\_segment.

The data associated with a Line\_plant\_item\_branch\_connection are the following:

— branch\_sequence\_id;

— line\_number.

##### **4.2.201.1 branch\_sequence\_id**

The branch\_sequence\_id specifies an alphanumeric identifier that indicates the order that branches extend from the main Piping\_system\_line\_segment (see 4.2.252).

##### **4.2.201.2 line\_number**

The line\_number specifies an alphanumeric identifier assigned to the Piping\_system\_line (see 4.2.251) and can be used to uniquely define the Piping\_system\_line. Line\_number is required for each Piping\_system\_line.

#### **4.2.202. Line\_plant\_item\_branch\_connector**

A `Line_plant_item_branch_connector` is a type of `Functional_connector` (see 4.2.128) that participates in a `Line_plant_item_branch_connection` (see 4.2.201).

#### **4.2.203.     `Line_plant_item_connection`**

A `Line_plant_item_connection` is a connection between the logical termination of a `Piping_system_line_segment` (see 4.2.252) and a `Line_plant_item_connector` (see 4.2.204).

The data associated with a `Line_plant_item_connection` are the following:

— `line_number`.

The `line_number` specifies an alphanumeric identifier assigned to the `Piping_system_line` (see 4.2.251) and can be used to uniquely define the `Piping_system_line`. `Line_number` is required for each `Piping_system_line`.

#### **4.2.204.     `Line_plant_item_connector`**

A `Line_plant_item_connector` is a type of `Functional_connector` (see 4.2.128) that participates in a `Line_plant_item_connection` (see 4.2.203).

#### **4.2.205.     `Line_plant_item_termination`**

A `Line_plant_item_termination` is a type of `Piping_system_line_segment_termination` (see 4.2.253) that connects to other `Line_to_line_termination` (see 4.2.207) objects.

The data associated with a `Line_plant_item_termination` are the following:

— `line_number`.

The `line_number` specifies an alphanumeric identifier assigned to the `Piping_system_line` (see 4.2.251) and can be used to uniquely define the `Piping_system_line`. `Line_number` is required for each `Piping_system_line`.

#### **4.2.206.     `Line_to_line_connection`**

A `Line_to_line_connection` is a connection between the logical terminations of two or more `Piping_system_line_segment` (see 4.2.252) objects.

#### **4.2.207.     `Line_to_line_termination`**

A `Line_to_line_termination` is a type of `Piping_system_line_segment_termination` (see 4.2.253) that connects to other `Line_to_line_termination` objects.

The data associated with a `Line_to_line_termination` are the following:

— `line_number`.

The `line_number` specifies an alphanumeric identifier assigned to the `Piping_system_line` (see 4.2.251) and can be used to uniquely define the `Piping_system_line`. `Line_number` is required for each `Piping_system_line`.

#### **4.2.208. Lined\_piping**

A `Lined_piping` is a type of `Piping_spool` (see 4.2.246) with coating material on the inner side.

The data associated with a `Lined_piping` are the following:

- `lining_thickness_inside_pipe`;
- `lining_thickness_at_flange_face`.

##### **4.2.208.1 lining\_thickness\_inside\_pipe**

The `lining_thickness_inside_pipe` specifies the thickness of the coating material on the inner surface of the `Piping_spool` (see 4.2.246).

##### **4.2.208.2 lining\_thickness\_at\_flange\_face**

The `lining_thickness_at_flange_face` specifies the thickness of the coating material on the connecting face of the `Flange` (see 4.2.119) at the ends of the `Piping_spool` (see 4.2.246) if the spool is terminated by a `Flange`.

#### **4.2.209. Load\_transference**

A `Load_transference` is a type of `Plant_item_connection` (see 4.2.263) that identifies the purpose or role of the connection as being the transfer of load or force.

#### **4.2.210. Location\_in\_building**

A `Location_in_building` is a type of `Plant_item_location` (see 4.2.272) that is the position of the `Plant_item` (see 4.2.260) relative to the `Building` (see 4.2.14).

#### **4.2.211. Location\_in\_plant**

A `Location_in_plant` is a type of `Plant_item_location` (see 4.2.272) that is the position of the `Plant_item` (see 4.2.260) relative to the `Plant` (see 4.2.258).

#### **4.2.212. Location\_in\_site**

A `Location_in_site` is a type of `Plant_item_location` (see 4.2.272) that is the position of the `Plant_item` (see 4.2.260) relative to the `Site` (see 4.2.313).

#### **4.2.213. Locked\_orientation\_connection**

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A `Locked_orientation_connection` is a type of `Plant_item_connection` (see **4.2.263**) in which two `Plant_item_connector` (see **4.2.265**) objects are in physical contact and there is no relative motion of the connected `Plant_item` (see **4.2.260**) objects with respect to each other.

NOTE A pump housing (containing the impeller and shaft) can be connected to the driver (motor) using a `Locked_orientation_connection`; this would mean that they move in unison.

### **4.2.214. Lug**

The Lug is a type of `Pipe_support` (see **4.2.248**) that consists of a simple plate with a hole to be hanged by. The Lug without a hole is used to support the weight in a manner similar to the Trunnion (see **4.2.363**).

EXAMPLE A spring hanger with or without a hole.

The data associated with a Lug are the following:

— length.

The length specifies the distance between the tip of the Lug and the `location_point`.

### **4.2.215. Male\_end**

A `Male_end` is a type of `Piping_connector` (see **4.2.242**) end type that forms a compatible connection with a `Female_end` (see **4.2.116**).

The data associated with a `Male_end` are the following

— `outer_end_preparation`;

— `inner_end_preparation`.

#### **4.2.215.1 outer\_end\_preparation**

The `outer_end_preparation` specifies a description of the outer end of the connector that is necessary to prepare it for welding.

#### **4.2.215.2 inner\_end\_preparation**

The `inner_end_preparation` specifies a description of the inner end of the connector that is necessary to prepare it for welding.

### **4.2.216. Manufacturing\_line**

A `Manufacturing_line` is a type of `Plant` (see **4.2.258**) that is defined by the type of product(s) it produces.

### **4.2.217. Material\_specification\_selection**

A `Material_specification_selection` is the candidate material specifications for piping system design. Each `Material_specification_selection` may be a `Material_specification_subset_reference` (see **4.2.218**).

The data associated with a `Material_specification_selection` are the following:

- description;
- `material_specification_id`;
- `required_or_optional`;
- `selection_id`;
- type.

EXAMPLE The `material_specification_selection` for a piping component would have a of type of "Stainless Steel", a `material_specification_id` of "ASTM (American Society for Testing and Materials) A403", a `selection_id` of "SS A316S", a description of "standard material callout", and be required.

#### **4.2.217.1 description**

The description specifies a textual explanation or summary of the selected material specification.

#### **4.2.217.2 material\_specification\_id**

The `material_specification_id` specifies a unique identifier for the material specification selected. `Material_specification_id` is required for each `Material_specification_selection`.

#### **4.2.217.3 required\_or\_optional**

The `required_or_optional` specifies whether the material specification is required or whether its use is optional.

#### **4.2.217.4 selection\_id**

The `selection_id` specifies a unique identifier for the candidate material specification. `Selection_id` is required for each `Material_specification_selection`.

#### **4.2.217.5 type**

The type specifies a designation that classifies a `Material_specification_selection` based on selection criteria.

### **4.2.218. Material\_specification\_subset\_reference**

A `Material_specification_subset_reference` is a type of `Material_specification_selection` (see **4.2.217**) that is the reference parameters required to identify the applicable subset of a `Required_material_description` (see **4.2.299**).

The data associated with a `Material_specification_subset_reference` are the following:

- `subset_id`.

The `subset_id` specifies a unique identifier for the specified subset portion of a Required\_material\_description (see 4.2.299). `Subset_id` is required for each Material\_specification\_subset\_reference.

NOTE The subset reference is used when further subdivisions of the material specification selection are provided to allow for a more precise specification of the material.

### 4.2.219. Mitre\_bend\_pipe

A `Mitre_bend_pipe` is a type of `Pipe` (see 4.2.236) that is a change in `Pipe` direction accomplished through the use of two or more straight sections of `Pipe` that are beveled and joined on a line bisecting the angle of junction.

NOTE Figure 41 depicts a typical `Mitre_bend_pipe`.

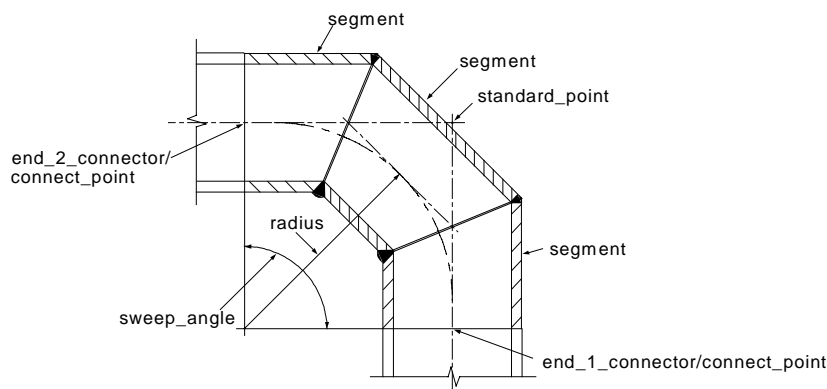


Figure 41 - `Mitre_bend_pipe`

The data associated with a `Mitre_bend_pipe` are the following:

- `number_of_segments`;
- `radius`;
- `sweep_angle`.

#### 4.2.219.1 `number_of_segments`

The `number_of_segments` specifies the number of distinct straight sections of `Pipe` (see 4.2.236) that constitute the `Mitre_bend_pipe`.

#### 4.2.219.2 `radius`

The `radius` specifies the measure of the radius of curvature for a `Mitre_bend_pipe`. It may be specified as a single value or as a range of values.

NOTE See annex L for a discussion of attributes that may be assigned a single value or a range of values.

#### 4.2.219.3 `sweep_angle`

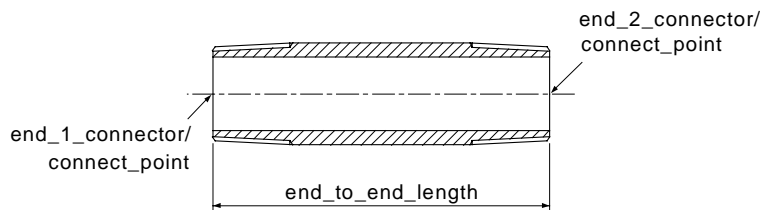
The `sweep_angle` specifies the angular measure at the centre of curvature from one end of the `Mitre_bend_pipe` to other. It may be specified as a single value or as a range of values.

NOTE See annex L for a discussion of attributes that may be assigned a single value or a range of values.

#### 4.2.220. Nipple

A Nipple is a type of Pipe (see 4.2.236) that is commonly acquired in prefabricated lengths and end preparations. Nipples are generally small in size in comparison to other pipes in a piping system.

NOTE Figure 42 depicts a typical Nipple.



**Figure 42 - Nipple**

The data associated with a Nipple are the following

— `end_to_end_length`.

The `end_to_end_length` specifies the external distance between the end-one face and the end-two face of the nipple. It may be specified as a single value or as a range of values.

NOTE See annex L for a discussion of attributes that may be assigned a single value or a range of values.

#### 4.2.221. Node

A Node is a `Functional_connector` (see 4.2.128) that defines the positional placement for physical components along a Route (see 4.2.302).

#### 4.2.222. Nozzle

A Nozzle is a type of `Plant_item` (see 4.2.260) that is designed to facilitate the connection of another `Plant_item` object to a piece of Equipment (see 4.2.104). A Nozzle is generally permanently affixed to, and protrudes from, the Equipment item and is most commonly used to connect Piping\_components (see 4.2.240).

#### 4.2.223. Nut

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A Nut is a type of Bolt\_and\_nut\_component (see 4.2.9) that is used to fasten two or more Plant\_items (see 4.2.260) together. The Nut is an internally threaded fastener for Bolts (see 4.2.8) or screws.

The data associated with a Nut are the following:

— nut\_type.

The nut\_type specifies a classification of the Nut based on its shape characteristics.

EXAMPLE Examples of nut\_type designations include hexagon, hexagon\_with\_washer, and domed\_cap.

### 4.2.224. Offline\_instrument

An Offline\_instrument is a type of Instrument (see 4.2.188) that monitors the conditions of a system but is not an integral element of the system.

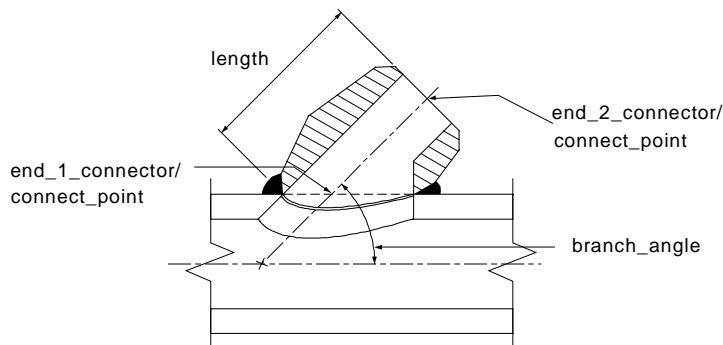
EXAMPLE Local panels, analyzer houses, junction box are examples of Offline\_instruments.

### 4.2.225. Olet

An Olet is a type of Fitting (see 4.2.118) welded onto a hole in the side of a Pipe (see 4.2.236) or other Fitting.

NOTE 1 The primary use of an Olet is for making small branch connections or connecting Instrument (see 4.2.188) lines to Piping\_component (see 4.2.240) objects.

NOTE 2 Figure 43 depicts a typical butt-welded latrolet, a kind of Olet.



**Figure 43 - Olet**

EXAMPLE Other kinds of Olets include weldolets, sweepolets, elbowlets, and sockolets.

The data associated with an Olet are the following:

— base\_outside\_diameter;

— branch\_angle;

- end\_1\_connector;
- end\_2\_connector;
- length;
- skirt\_outside\_diameter.

#### **4.2.225.1 base\_outside\_diameter**

The `base_outside_diameter` specifies the external diameter of the Olet at the surface that mates with the straight-run Pipe (see **4.2.236**). It may be specified as a single value or as a range of values.

NOTE See annex L for a discussion of attributes that may be assigned a single value or a range of values.

#### **4.2.225.2 branch\_angle**

The `branch_angle` specifies the angle that the branch projects from the straight run. It may be specified as a single value or as a range of values.

NOTE See annex L for a discussion of attributes that may be assigned a single value or a range of values.

#### **4.2.225.3 end\_1\_connector**

The `end_1_connector` specifies the `Piping_connector` (see **4.2.242**) that connects to the main Pipe (see **4.2.236**) or Fitting (see **4.2.118**).

#### **4.2.225.4 end\_2\_connector**

The `end_2_connector` specifies the `Piping_connector` (see **4.2.242**) that connects to the branch line.

#### **4.2.225.5 length**

The `length` specifies the distance between the end-one face and the end-two face at the centreline of the Olet. It may be specified as a single value or as a range of values.

NOTE See annex L for a discussion of attributes that may be assigned a single value or a range of values.

#### **4.2.225.6 skirt\_outside\_diameter**

The `skirt_outside_diameter` specifies the maximum external diameter of the Olet (measured perpendicular to the Olet centreline). It may be specified as a single value or as a range of values.

NOTE 1 See annex L for a discussion of attributes that may be assigned a single value or a range of values.

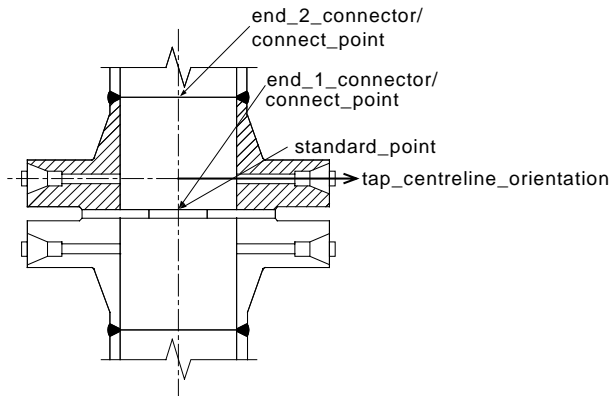
NOTE 2 The sides of an Olet are tapered (not vertical).

### **4.2.226. Orifice\_flange**

An `Orifice_flange` is a type of Flange (see **4.2.119**) used to assemble an `Inline_instrument` (see **4.2.183**) to meter the flow of liquids or gases in a pipe.

NOTE 1 Orifice\_flange objects are used in pairs in conjunction with an Orifice\_plate (see 4.2.227).

NOTE 2 Figure 44 depicts a typical Orifice\_flange and Orifice\_plate (see 4.2.227) configuration.



**Figure 44 - Orifice\_flange**

The data associated with an Orifice\_flange are the following:

- jacking\_screw\_orientation;
- tap;
- tap\_centreline\_orientation.

#### 4.2.226.1 jacking\_screw\_orientation

The jacking\_screw\_orientation specifies the angular position of the threaded bolt holes in an Orifice\_flange.

NOTE Jacking screws are used to separate the Orifice\_flange objects sufficiently to remove or insert the Orifice\_plate (see 4.2.227).

#### 4.2.226.2 tap

The tap specifies the Piping\_connector (see 4.2.242) designated as the tap.

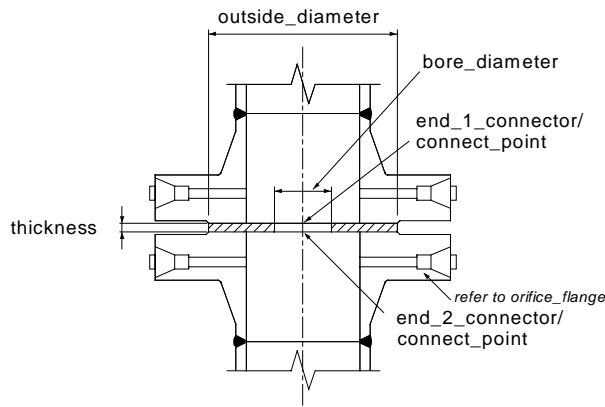
#### 4.2.226.3 tap\_centreline\_orientation

The tap\_centreline\_orientation specifies the orientation of the tap's centreline of the Orifice\_flange. It is specified as direction values within the plant coordinate system.

### 4.2.227. Orifice\_plate

An Orifice\_plate is a type of Fitting (see 4.2.118) that is a disk with a calibrated hole that is placed in a Pipe (see 4.2.236) to measure flow.

NOTE Figure 45 depicts a typical Orifice\_plate.



**Figure 45 - Orifice\_plate**

The data associated with an Orifice\_plate are the following:

- beta\_ratio;
- bore\_diameter;
- outside\_diameter;
- thickness.

#### **4.2.227.1 beta\_ratio**

The beta\_ratio is defined as the diameter of the hole in the Orifice\_plate divided by the inside diameter of the Pipe (see 4.2.236).

#### **4.2.227.2 bore\_diameter**

The bore\_diameter specifies the diameter of the hole in the Orifice\_plate. It may be specified as a single value or as a range of values.

NOTE See annex L for a discussion of attributes that may be assigned a single value or a range of values.

#### **4.2.227.3 outside\_diameter**

The outside\_diameter specifies the external diameter of the Orifice\_plate. It may be specified as a single value or as a range of values.

NOTE See annex L for a discussion of attributes that may be assigned a single value or a range of values.

#### **4.2.227.4 thickness**

The thickness specifies the perpendicular distance between the two faces of the Orifice\_plate. It may be specified as a single value or as a range of values.

NOTE See annex L for a discussion of attributes that may be assigned a single value or a range of values.

### **4.2.228. Outline\_shape**

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An Outline\_shape is a type of Shape\_representation (see **4.2.309**) that is a 3D spatial volume that corresponds to the bounding surface features of a Plant\_item (see **4.2.260**).

NOTE Contrast with Detail\_shape (see **4.2.88**) and Envelope\_shape (see **4.2.103**). An Outline\_shape is a simple geometric representation of Plant\_item (see **4.2.260**); this representation may be called a cartoon. The representation is a more accurate representation of the shape of the Plant\_item than that provided by an Envelope\_shape, but not nearly as precise as a Detailed\_shape.

### **4.2.229. Outside\_and\_thickness**

An Outside\_and\_thickness is a type of Piping\_size\_description (see **4.2.244**) that describes the size by providing the outside diameter and thickness values.

The data associated with an Outside\_and\_thickness are the following:

- outside\_diameter;
- thickness.

#### **4.2.229.1 outside\_diameter**

The outside\_diameter specifies the external diameter of the Piping\_system\_component (see **4.2.250**) or Piping\_connector (see **4.2.242**). It may be specified as a single value or as a range of values.

NOTE See annex L for a discussion of attributes that may be assigned a single value or a range of values.

#### **4.2.229.2 thickness**

The thickness specifies the minimum distance between the inside and outside piping wall surfaces of the Piping\_system\_component (see **4.2.250**) or Piping\_connector (see **4.2.242**). It may be specified as a single value or as a range of values.

NOTE See annex L for a discussion of attributes that may be assigned a single value or a range of values.

### **4.2.230. Paddle\_blank**

A Paddle\_blank is a type of Blank (see **4.2.5**) that reserves space between two Flange (see **4.2.119**) objects and blocks the flow of material.

NOTE A Paddle\_blank has a handle that permits removal or repositioning of the Paddle\_blank. The name is derived from the fact that the Paddle\_blank looks like a ping pong paddle.

The data associated with a Paddle\_blank are the following:

- paddle\_length;
- paddle\_width.

#### **4.2.230.1 paddle\_length**

The `paddle_length` specifies the length of the handle on the `Paddle_blank`. It may be specified as a single value or as a range of values.

NOTE 1 The length is measured from the outside diameter of the Blank (see 4.2.5).

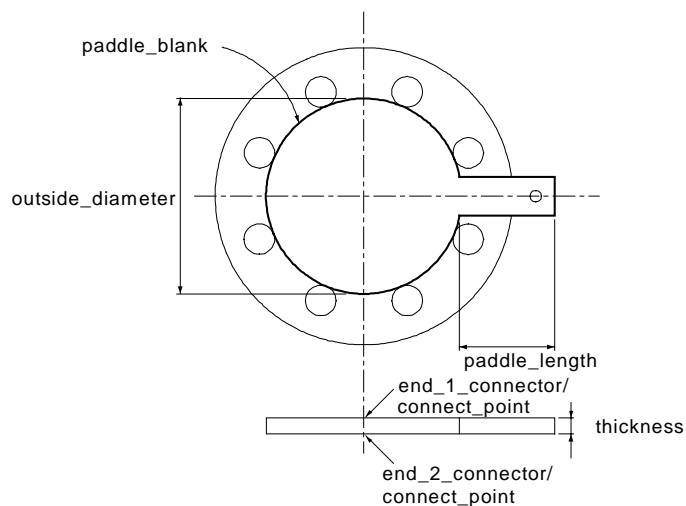
NOTE 2 See annex L for a discussion of attributes that may be assigned a single value or a range of values.

#### 4.2.230.2 `paddle_width`

The `paddle_width` specifies the width of the handle on the `Paddle_blank`. It may be specified as a single value or as a range of values.

NOTE 1 See annex L for a discussion of attributes that may be assigned a single value or a range of values.

NOTE 2 Figure 46 depicts a typical `Paddle_blank`.



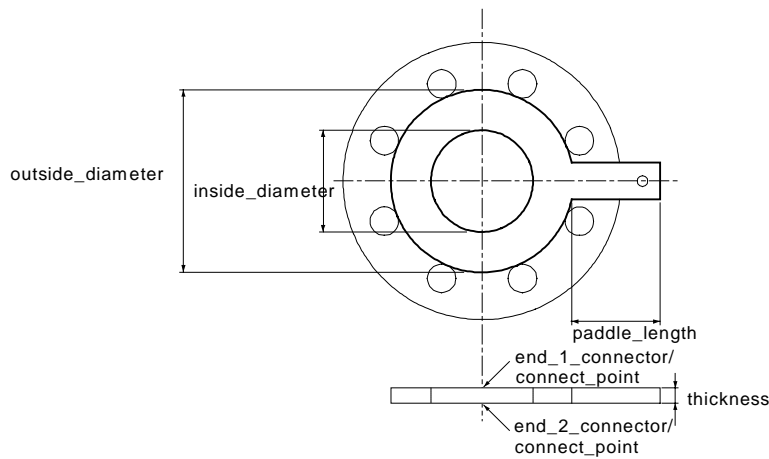
**Figure 46 - Paddle\_blank**

#### 4.2.231. `Paddle_spacer`

A `Paddle_spacer` is a type of `Spacer` (see 4.2.322) that reserves space between two `Flange` (see 4.2.119) objects and permits flow through the `Pipe` (see 4.2.236).

NOTE 1 A `Paddle_spacer` has a handle that permits its removal or repositioning. The inner diameter of the `Paddle_spacer` may be less than the diameter of the `Pipe` (see 4.2.236), thus altering flow.

NOTE 2 Figure 47 depicts a typical `Paddle_spacer`.



**Figure 47 - Paddle\_spacer**

The data associated with a Paddle\_spacer are the following:

- inside\_diameter;
- paddle\_length;
- paddle\_width.

#### **4.2.231.1 inside\_diameter**

The inside\_diameter specifies the diameter of the bore hole through the Paddle\_spacer. It may be specified as a single value or as a range of values.

NOTE See annex L for a discussion of attributes that may be assigned a single value or a range of values.

#### **4.2.231.2 paddle\_length**

The paddle\_length specifies the length of the handle of the Paddle\_spacer. It may be specified as a single value or as a range of values.

NOTE 1 The length is measured from the outside diameter of the Paddle\_spacer.

NOTE 2 See annex L for a discussion of attributes that may be assigned a single value or a range of values.

#### **4.2.231.3 paddle\_width**

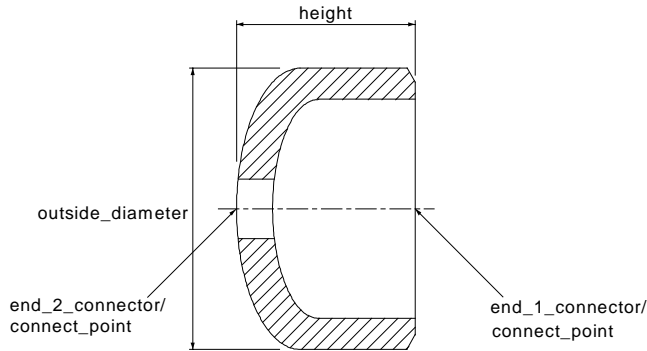
The paddle\_width specifies the width of the handle of the Paddle\_spacer. It may be specified as a single value or as a range of values.

NOTE See annex L for a discussion of attributes that may be assigned a single value or a range of values.

### **4.2.232. Perforated\_cap**

A Perforated\_cap is a type of Cap (see 4.2.25) with a hole on its closing surface.

NOTE Figure 48 depicts a typical Perforated\_cap.



**Figure 48 - Perforated\_cap**

The data associated with a Perforated\_cap are the following:

- end\_2\_connector;
- hole\_diameter.

#### **4.2.232.1 end\_2\_connector**

The end\_2\_connector specifies the Piping\_connector (see 4.2.242) where the inside Pipe (see 4.2.236) of the jacketed piping connects to the Perforated\_cap.

#### **4.2.232.2 hole\_diameter**

The hole\_diameter is the diameter of the hole in the Perforated\_cap.

### **4.2.233. Perforated\_plate**

A Perforated\_plate is a type of Plate (see 4.2.279) with a hole on its surface.

The data associated with a Perforated\_plate are the following:

- end\_2\_connector;
- hole\_diameter.

#### **4.2.233.1 end\_2\_connector**

The end\_2\_connector specifies the Piping\_connector (see 4.2.242) where the inside Pipe (see 4.2.236) of the jacketed piping connects to the Perforated\_plate.

#### **4.2.233.2 hole\_diameter**

The hole\_diameter is the diameter of the hole in the Perforated\_plate.

#### **4.2.234. Physical\_connector**

A `Physical_connector` is a type of `Plant_item_connector_occurrence` (see **4.2.266**) that represents the physical aspects of the `Plant_item_connector_occurrence`.

#### **4.2.235. Physical\_design\_view**

A `Physical_design_view` is a type of `Plant_item_design_view` (see **4.2.268**) that describes the physical and spatial characteristics of a `Plant_item` (see **4.2.260**).

#### **4.2.236. Pipe**

A `Pipe` is a type of `Piping_component` (see **4.2.240**) that is a hollow cylindrical conveyance, with a constant radius for the cross-sectional circle, for directing fluid, vapour, or particulate flow. Each `Pipe` may be one of the following: a `Mitre_bend_pipe` (see **4.2.219**), a `Nipple` (see **4.2.220**), a `Straight_pipe` (see **4.2.332**), or a `Swept_bend_pipe` (see **4.2.349**).

NOTE 1 In most cases, the `Pipe` will conform to the dimensional requirements for nominal pipe size as tabulated in national standards such as American National Standards Institute (ANSI) B36.10 and ANSI B36.19.

NOTE 2 This definition does not exclude tubing and flex hoses from consideration as `Pipe`.

The data associated with a `Pipe` are the following:

- `additional_length`;
- `end_1_connector`;
- `end_2_connector`.

##### **4.2.236.1 additional\_length**

The `additional_length` specifies the length of `Pipe` that is extended from the designed length of the `Pipe` to allow for installation error.

##### **4.2.236.2 end\_1\_connector**

The `end_1_connector` specifies the `Piping_connector` (see **4.2.242**) that connects to one end of the `Pipe`.

##### **4.2.236.3 end\_2\_connector**

The `end_2_connector` specifies the `Piping_connector` (see **4.2.242**) that connects to the other end of the `Pipe`.

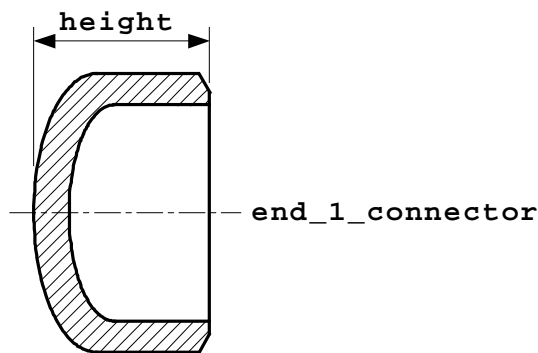
#### **4.2.237. Pipe\_closure**

A Pipe\_closure is a type of Fitting (see **4.2.118**) used to close an end of a Piping\_component (see **4.2.240**).

Each Pipe\_closure may be one of the following: Cap (see **4.2.25**), Plug (see **4.2.280**), or Plate (see **4.2.279**).

NOTE 1 Blind\_flange (see 4.2.6) objects also perform the function of closing a Piping\_system (see 4.2.249). However, industry terminology treats them differently and they have been defined as separate objects.

NOTE 2 Figure 49 depicts a typical butt-weld Pipe Cap, which is a kind of Pipe\_closure.



**Figure 49 - Butt-weld Pipe Cap**

The data associated with a Pipe\_closure are the following:

- end\_1\_connector;
- shape\_type.

#### **4.2.237.1 end\_1\_connector**

The end\_1\_connector specifies the Piping\_connector (see **4.2.242**) that connects to the Pipe (see **4.2.236**).

#### **4.2.237.2 shape\_type**

The shape\_type is a type of Shape\_representation (see **4.2.309**).

### **4.2.238. Piping\_assembly**

A Piping\_assembly is an assembled collection of piping Plant\_item (see **4.2.260**) objects.

The data associated with a Piping\_assembly are the following:

- piping\_assembly\_number.

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The `piping_assembly_number` specifies an alphanumeric identifier assigned to the `Piping_assembly`.

NOTE A `Piping_assembly` may be defined to meet transportation, fabrication, or erection requirements.

### **4.2.239.     `Piping_assembly_assignment`**

A `Piping_assembly_assignment` is the identification of the `Piping_assembly` (see **4.2.238**) that a `Piping_component` (see **4.2.240**) belongs to.

### **4.2.240.     `Piping_component`**

A `Piping_component` is a type of `Piping_system_component` (see **4.2.250**) whose primary function is the conveyance or control of fluid flow. Each `Piping_component` may be one of the following: a `Fitting` (see **4.2.118**), a `Pipe` (see **4.2.236**), or a `Valve` (see **4.2.367**).

The data associated with a `Piping_component` are the following:

- `pmi_record`;
- `side_connector`;
- `standard_point`;
- `mill_sheet_number`.

#### **4.2.240.1 `pmi_record`**

The `pmi_record` attribute specifies an identifier of the positive material identification document for a `Piping_component`.

#### **4.2.240.2 `side_connector`**

The `side_connector` specifies the `Piping_connector` (see **4.2.242**) that is located between the two ends of the `Piping_component`. There may be more than one `side_connector` for a `Piping_component`.

#### **4.2.240.3 `standard_point`**

The `standard_point` specifies an x, y, z coordinate position defined for the `Piping_component` that will position the `Piping_component` in the Plant (see **4.2.258**) when overlayed on the Node (see **4.2.221**).

#### **4.2.240.4 `mill_sheet_number`**

The `mill_sheet_number` specifies an identifier of the document that comes from the mill providing a record of the raw material that comprises the `Piping_component`.

## 4.2.241. Piping\_component\_inspection\_record

A Piping\_component\_inspection\_record is a collection of information that captures the result of an evaluation of an observed value for a characteristic of a Piping\_component (see 4.2.240) against an expected, designed or prescribed value for that characteristic, as well as information to evaluate the acceptability of the observed value.

The data associated with a Piping\_component\_inspection\_record are the following:

- inspected\_property\_name;
- inspected\_property\_tolerance;
- inspected\_property\_measured\_value.

### 4.2.241.1 inspected\_property\_name

The inspected\_property\_name specifies the characteristic for which information is being recorded. The inspected\_property\_name may be one of the following:

- branch angle;
- flange face type;
- threaded type;
- end preparation shape;
- flange inside diameter dimension;
- flat side orientation;
- hole straddle centreline orientation;
- hub inside diameter dimension;
- hub outside diameter dimension;
- hub weld point diameter dimension;
- hub weld point thickness dimension;
- inside diameter dimension;
- longitudinal welding seam orientation;
- nominal size;
- pipe schedule;
- pressure rating;
- weld point outside diameter dimension;
- weld point thickness dimension;
- weld point inside diameter dimension;
- stand off dimension;
- centreline radius dimension;
- outside diameter dimension;
- thickness dimension;
- swept angle;
- ovality;
- tap orientation;
- paddle orientation.

### 4.2.241.2 inspected\_property\_tolerance

The inspected\_property\_tolerance specifies the acceptable deviation for the measured result of the inspection.

The inspected\_property\_measured\_value specifies the recorded result of the inspection.

## **4.2.242. Piping\_connector**

A Piping\_connector is a type of Plant\_item\_connector (see **4.2.265**) that is intended to establish a material flow connection between two Plant\_item (see **4.2.260**) objects. Each Piping\_connector may be one of the following: a Buttweld (see **4.2.16**), a Clamped (see **4.2.63**), a Flanged (see **4.2.120**), a Pressure\_fit (see **4.2.285**), a Socket (see **4.2.319**), a Stub\_in (see **4.2.338**), or a Threaded (see **4.2.352**). The end\_type of each Piping\_connector may be one of the following: a Branch\_hole (see **4.2.12**), a Female\_end (see **4.2.116**), a Flanged\_end (see **4.2.121**), a Flared\_end (see **4.2.122**), a Grooved\_end (see **4.2.137**), or a Male\_end (see **4.2.215**).

The data associated with a Piping\_connector are the following:

- connector\_flow\_direction;
- connector\_specification;
- name.

### **4.2.242.1 connector\_flow\_direction**

The connector\_flow\_direction specifies an indication of the way process fluid moves past the Plant\_item (see **4.2.260**).

### **4.2.242.2 connector\_specification**

The connector\_specification identifies the specification associated with the Piping\_connector. There may be more than one connector\_specification for a Piping\_connector.

EXAMPLE Examples of the identified connector\_specification include insulation specification, end preparation specification, and thread specification.

### **4.2.242.3 name**

The name specifies a textual label given to the Piping\_connector.

## **4.2.243. Piping\_connector\_service\_characteristic**

A Piping\_connector\_service\_characteristic is the conditions that the Piping\_connector (see **4.2.242**) is designed to withstand.

The data associated with a Piping\_connector\_service\_characteristic are the following:

- design\_pressure;
- design\_temperature.

### **4.2.243.1 design\_pressure**

The `design_pressure` specifies the maximum allowable pressure at the `Piping_connector` (see **4.2.242**). It may be specified as a single value or as a range of values.

NOTE 1 This value is normally created as part of doing 3D analysis of the piping system design.

NOTE 2 See annex L for a discussion of attributes that may be assigned a single value or a range of values.

#### **4.2.243.2 design\_temperature**

The `design_temperature` specifies the maximum allowable temperature at the `Piping_connector` (see **4.2.242**). It may be specified as a single value or as a range of values.

NOTE 1 This value is normally created as part of doing 3D analysis of the piping system design.

NOTE 2 See annex L for a discussion of attributes that may be assigned a single value or a range of values.

### **4.2.244. Piping\_size\_description**

A `Piping_size_description` is used to explain or summarize the physical size of a `Piping_connector` (see **4.2.242**) or `Piping_system_component` (see **4.2.250**), based on a set of dimensional characteristics, and an optional dimensional standard. Each `Piping_size_description` is either an `Inside_and_thickness` (see **4.2.185**), an `Outside_and_thickness` (see **4.2.229**), a `Pressure_class` (see **4.2.284**), or a `Schedule` (see **4.2.303**).

NOTE A `Piping_size_description` is used to specify the size of a `Piping_component` (see **4.2.240**) as a whole (where the size is constant over the extent of the component) or to each individual connector of the `Piping_component` (where the sizes of each different connector differ.)

The data associated with a `Piping_size_description` are the following:

- `dimensional_standard`;
- `ovality_allowance`.

#### **4.2.244.1 dimensional\_standard**

The `dimensional_standard` specifies a designation for the standard used to dimension the Pipe (see **4.2.236**). The `dimensional_standard` need not be specified for a particular `Piping_size_description`.

EXAMPLE Examples of `dimensional_standard` designations include ANSI and DIN.

#### **4.2.244.2 ovality\_allowance**

The `ovality_allowance` specifies the acceptable deviation or tolerance allowed in the 'out-of-roundness' of the `Piping_connector` (see **4.2.242**) or `Piping_system_component` (see **4.2.250**). In other words, it specifies how much the `Piping_connector` or `Piping_system_component` can deviate from a perfect circle. The `ovality_allowance` need not be specified for a particular `Piping_size_description`.

### **4.2.245. Piping\_specification**

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A Piping\_specification is a specification of conditions such as pressure, material, and corrosion allowance that must be met in a Piping\_system\_line\_segment (see **4.2.252**) and may include a list of Piping\_component (see **4.2.240**) objects by size range that meet these conditions.

NOTE The Piping\_specification is used in Spec-driven design, where the user specifies the size and component type, and the Piping\_specification is used to look-up the correct component characteristics. The components listed in the Piping\_specification may reference component catalogues.

The data associated with a Piping\_specification are the following:

- name;
- owner;
- piping\_specification\_id;
- service\_description.

### 4.2.245.1 name

The name specifies a textual label given to the Piping\_specification.

### 4.2.245.2 owner

The owner specifies the designation given to the person or organization that created and maintains the Piping\_specification.

### 4.2.245.3 piping\_specification\_id

The piping\_specification\_id specifies a unique identifier for the Piping\_specification. Piping\_specification\_id is required for each Piping\_specification.

### 4.2.245.4 service\_description

The service\_description specifies a textual explanation or summary of the process stream conditions that are supported by the Plant\_item (see **4.2.260**) objects described in the Piping\_specification.

## 4.2.246. Piping\_spool

A Piping\_spool is a collection of piping Plant\_item (see **4.2.260**) objects.

A Piping\_spool is an assembly of Piping\_components (see **4.2.240**) and applicable Plant\_items (see **4.2.260**) such as Piping\_support (see **4.2.248**) attachment to be shop fabricated and physically connected into one item.

The data associated with a Piping\_spool are the following:

- tag\_number;
- piping\_type;

— temporary\_flag.

#### **4.2.246.1 tag\_number**

The tag\_number is a unique identification of the Piping\_spool.

#### **4.2.246.2 piping\_type**

The piping\_type specifies whether a Piping\_spool is comprised of single or jacketed piping. The value of piping\_type is one of the following:

— jacketed

— single

##### **4.2.246.2.1 jacketed**

Jacketed Piping\_spool has inner piping and outer piping.

##### **4.2.246.2.2 single**

A single Piping\_spool has no jacket.

#### **4.2.246.3 temporary\_flag**

The temporary flag specifies whether the Piping\_spool is a temporary spool, usually having flanged connectors, that is to be replaced with a different Piping\_component (see **4.2.240**) at some point in the construction of the Plant (see **4.2.258**).

### **4.2.247. Piping\_spool\_inspection\_record**

A Piping\_spool\_inspection\_record is a collection of information that captures the result of an evaluation of an observed value for a characteristic of a Piping\_spool (see **4.2.246**) against an expected, designed or prescribed value for that characteristic, as well as information to evaluate the acceptability of the observed value.

The data associated with a Piping\_spool\_inspection\_record are the following

— inspected\_preproperty\_name;

— inspected\_property\_tolerance;

— inspected\_property\_measured\_value.

#### **4.2.247.1 inspected\_property\_name**

The inspected\_property\_name specifies the characteristic for which information is being recorded. The inspected\_property\_name may be one of the following:

— piping spool configuration inspection;

— pressure test;

— leak test;

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- visual examination;
- surface painting;
- marking;
- packed figure;
- end protection;
- high voltage for pin hole detective;
- lining thickness.

### **4.2.247.2 inspected\_property\_tolerance**

The inspected\_property\_tolerance specifies the acceptable deviation for the measured result of the inspection.

### **4.2.247.3 inspected\_property\_measured\_value**

The inspected\_property\_measured\_value specifies the recorded result of the inspection.

## **4.2.248. Piping\_support**

A Piping\_support is a type of Support\_component (see **4.2.343**) that is fabricated onto the pipe, and supports the Piping\_spool (see **4.2.246**) when it is installed into the Plant (see **4.2.258**).

The data associated with a Piping\_support are the following:

- end\_1\_connector;
- location\_point;
- orientation.

### **4.2.248.1 end\_1\_connector**

The end\_1\_connector specifies the Piping\_connector (see **4.2.242**) on the Piping\_support to the pipe.

### **4.2.248.2 location\_point**

The location\_point is a standard point on Piping\_component (see **4.2.240**) at which the Piping\_support is attached.

EXAMPLE When a Base\_elbow\_support (see 4.2.3) is attached to an Elbow (see 4.2.98), the location\_point is the centre of the Elbow, where the centrelines of two arms of Elbow intersect.

When a Base\_line\_support (see 4.2.4) is attached to a Straight\_pipe (see 4.2.332), the location\_point is the intersection of the centrelines of the Straight\_pipe and the main body of the Base\_line\_support.

### **4.2.248.3 orientation**

The orientation specifies a unit vector in the direction of the main part of the Piping\_support. The vector defines the layout of the Piping\_support.

#### **4.2.248.4 piping support types**

Necessary information for piping shop fabrication: type, location point, orientation and dimensional parameters. Types of Piping\_supports include: Base\_elbow\_support (Adjustable and Non-adjustable) (see 4.2.3), Base\_line\_support (see 4.2.4), Dummy\_leg (see 4.2.92), Eccentric\_base\_elbow\_support (see 4.2.93), Lug (see 4.2.214), Shoe (see 4.2.312), Stopper (see 4.2.331), and Trunnion (see 4.2.363).

### **4.2.249. Piping\_system**

A Piping\_system is a type of Plant\_system (see 4.2.276) that is a system of interconnected Plant\_item (see 4.2.260) objects that convey fluid, vapour, or particulate flow throughout a plant. Each Piping\_system may be a Line\_less\_piping\_system (see 4.2.199).

EXAMPLE Methods of flow conveyance through the Piping\_system include mechanical, gravitational, and electromagnetic induction.

The data associated with a Piping\_system are the following:

- code;
- description.

#### **4.2.249.1 code**

The code specifies the name of the specification that the Piping\_system needs to conform to.

#### **4.2.249.2 description**

The description specifies a textual explanation or summary of the Piping\_system.

### **4.2.250. Piping\_system\_component**

A Piping\_system\_component is a type of Plant\_item (see 4.2.260) that is a constituent element of a Piping\_system (see 4.2.249). Each Piping\_system\_component may be one of the following: an Inline\_equipment (see 4.2.182), an Inline\_instrument (see 4.2.183), a Piping\_component (see 4.2.240), a Process\_ducting (see 4.2.286), or a Specialty\_item (see 4.2.324).

The data associated with a Piping\_system\_component are the following:

- coating\_reference;
- corrosion\_allowance;
- heat\_tracing\_type;
- lining.

#### **4.2.250.1 coating\_reference**

The `coating_reference` specifies a reference to the specification of the substances used to coat the surfaces of a `Piping_system_component`. For a given `Piping_system_component`, the value of this attribute overrides any global specification.

#### **4.2.250.2 corrosion\_allowance**

The `corrosion_allowance` specifies the depth that corrosion may encroach below the surface of a `Piping_system_component` before action is required. For a given `Piping_system_component`, the value of this attribute overrides any global specification. It may be specified as a single value or as a range of values.

NOTE See annex L for a discussion of attributes that may be assigned a single value or a range of values. The depth of the corrosion may vary over the extent of the `Piping_component` (see **4.2.240**).

#### **4.2.250.3 heat\_tracing\_type**

The `heat_tracing_type` specifies the means utilized to impart a temperature increase to the `Piping_system_component` by an external wrapping or coiling. For a given `Piping_system_component`, the value of this attribute overrides any global specification.

NOTE Types may include electrical or steam.

#### **4.2.250.4 lining**

The `lining` specifies a description of the substances used to line the internal surfaces of a `Piping_system_component`.

### **4.2.251. Piping\_system\_line**

A `Piping_system_line` is a logical component of a `Piping_system` (see **4.2.249**) and is composed of a collection of interconnected `Piping_system_line_segment` (see **4.2.252**) objects.

The data associated with a `Piping_system_line` are the following:

- `line_number`;
- `P_and_I_reference`.

#### **4.2.251.1 line\_number**

The `line_number` specifies an alphanumeric identifier assigned to the `Piping_system_line` and can be used to uniquely define the `Piping_system_line`. `Line_number` is required for each `Piping_system_line`.

EXAMPLE A1A-PX-100-4-150, is a coded number that identifies the `Piping_system_line` and the main design criteria - specification = A1A, process = PX, line number = 100, line size = 4, and pressure rating = 150.

#### **4.2.251.2 P\_and\_I\_reference**

The `P_and_I` reference specifies the piping and instrumentation diagram that depicts the `Piping_system_line`.

### **4.2.252. Piping\_system\_line\_segment**

A `Piping_system_line_segment` is an element of a `Piping_system_line` (see **4.2.251**). A `Piping_system_line_segment` terminates at a functional `Plant_item_connector` (see **4.2.265**), a tap into a `Piping_system_line`, a point where the stream diverges or converges, a vent, or a drain.

The data associated with a `Piping_system_line_segment` are the following:

- `coating_reference`;
- `corrosion_allowance`;
- `design_pressure`;
- `design_temperature`;
- `elevation`;
- `heat_tracing_type`;
- `line_number`;
- `line_size`.

#### **4.2.252.1 coating\_reference**

The `coating_reference` specifies a reference to the specification that details the coating requirements of the `Piping_component` (see **4.2.240**) objects associated with the `Piping_system_line` (see **4.2.251**).

#### **4.2.252.2 corrosion\_allowance**

The `corrosion_allowance` specifies the depth that corrosion may encroach below the surface of components on a `Piping_system_line_segment` before action is required. For a given `Piping_system_component` (see **4.2.250**), the value of this attribute overrides any global specification.

#### **4.2.252.3 design\_pressure**

The `design_pressure` specifies the requirement for maximum allowable pressure of the `Piping_component` (see **4.2.240**) objects associated with the `Piping_system_line` (see **4.2.251**).

#### **4.2.252.4 design\_temperature**

The `design_temperature` specifies the requirement for maximum allowable temperature of the `Piping_component` (see **4.2.240**) objects associated with the `Piping_system_line` (see **4.2.251**).

#### **4.2.252.5 elevation**

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The elevation specifies the distance above sea level that the piping assigned to the line should exist.

### **4.2.252.6 heat\_tracing\_type**

The `heat_tracing_type` specifies the heating method used to maintain temperature in the `Piping_system_line` (see **4.2.251**).

EXAMPLE Heating method designations include steam tracing and electrical.

### **4.2.252.7 line\_number**

The `line_number` specifies an alphanumeric identifier assigned to the `Piping_system_line` (see **4.2.251**) and can be used to uniquely define the `Piping_system_line`. `Line_number` is required for each `Piping_system_line`.

### **4.2.252.8 line\_size**

The `line_size` specifies the intended diameter of the piping to be selected to satisfy the `Piping_system_line` (see **4.2.251**). The `line_size` need not be specified for a particular `Piping_system_line_segment` where the `Piping_system_line_segment` corresponds to one `Piping_system_component` (see **4.2.250**).

NOTE When the `line_size` is not specified, it is either ambiguous due to the nature of the `Piping_system_component` (see **4.2.250**) such as a Reducer (see **4.2.292**), or derivable from one or more of the connecting `Piping_system_line_segments`.

## **4.2.253. Piping\_system\_line\_segment\_termination**

A `Piping_system_line_segment_termination` is one of two logical end-points of a `Piping_system_line_segment` (see **4.2.252**). Each `Piping_system_line_segment_termination` is either: a `Line_branch_termination` (see **4.2.198**), a `Line_to_line_termination` (see **4.2.207**), a `Line_plant_item_termination` (see **4.2.205**), or `Piping_system_line_termination` (see **4.2.254**).

NOTE `Piping_system_line` (see **4.2.251**) objects are composed of individual `Piping_system_line_segment` (see **4.2.252**) objects. `Piping_system_line_segment` objects are connected through `Piping_system_line_segment_termination` objects.

The data associated with a `Piping_system_line_segment_termination` are the following:

- `flow_direction`;
- `line_number`.

### **4.2.253.1 flow\_direction**

The `flow_direction` specifies the direction of material flow at the `Piping_system_line_segment_termination`. The value of the `flow_direction` attribute shall be one of the following:

- both;

- in;
- not\_specified;
- out.

**4.2.253.1.1 both:** material may flow in either direction past the Piping\_system\_line\_segment\_termination.

**4.2.253.1.2 in:** material flows into the line segment past the Piping\_system\_line\_segment\_termination.

**4.2.253.1.3 not\_specified:** the direction of material flow past the Piping\_system\_line\_segment\_termination is not specified.

**4.2.253.1.4 out:** material flows out of the line segment past the Piping\_system\_line\_segment\_termination.

#### **4.2.253.2 line\_number**

The line\_number specifies an alphanumeric identifier assigned to the Piping\_system\_line (see **4.2.251**) and can be used to uniquely define the Piping\_system\_line. Line\_number is required for each Piping\_system\_line.

### **4.2.254. Piping\_system\_line\_termination**

A Piping\_system\_line\_termination is a type of Piping\_system\_line\_segment\_termination (see **4.2.253**) that begins or ends a Piping\_system\_line (see **4.2.251**).

The data associated with a Piping\_system\_line\_termination are the following:

- location;
- position\_on\_pipe;
- start\_or\_end.

#### **4.2.254.1 location**

The location specifies the relative distance in the X, Y, Z directions of the position of the end of the Piping\_system\_line (see **4.2.251**), from the plant origin. The location position may also be defined by where it connects to an upstream piece of Equipment (see **4.2.104**) or Piping\_system\_line.

#### **4.2.254.2 position\_on\_pipe**

The position\_on\_pipe specifies an indicator of the relationship between the point and the Piping\_component (see **4.2.240**) that will eventually satisfy it.

NOTE If the indicator is not specified, the assumed value is Centre Of Pipe (COP).

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EXAMPLE A position\_on\_pipe may be COP or BOP indicating that the location of the Piping\_system\_line\_termination location is on the centre or bottom of the pipe.

### **4.2.254.3 start\_or\_end**

The start\_or\_end specifies an enumerated value that defines the side of the pipe on which the line termination lies. A value of 'start' indicates the line termination is on the upstream end, and a value of 'end' indicates that the line termination is on the downstream end.

### **4.2.255. Plain\_washer**

A Plain\_washer is a type of Washer (see **4.2.369**). The shape of the Plain\_washer is a thin flat ring.

The data associated with a Plain\_washer are the following:

- thickness;
- outside\_diameter.

#### **4.2.255.1 thickness**

The thickness specifies the distance between two faces of the Plain\_washer. It may be specified as a single value or as a range of values.

NOTE See annex L for a discussion of attributes that may be assigned a single value or a range of values.

#### **4.2.255.2 outside\_diameter**

The outside\_diameter specifies the external diameter of the Plain\_washer. It may be specified as a single value or as a range of values.

NOTE See annex L for a discussion of attributes that may be assigned a single value or a range of values.

### **4.2.256. Planned\_physical\_plant**

A Planned\_physical\_plant is the set of physical and spatial characteristics that a Plant (see **4.2.258**) can have, including siting, location, and orientation.

NOTE A Planned\_physical\_plant can also be the basis for locating other items such as Plant\_item (see **4.2.260**) objects, Plant\_item\_location (see **4.2.272**).

### **4.2.257. Planned\_physical\_plant\_item**

A Planned\_physical\_plant\_item is a type of Plant\_item\_instance (see **4.2.269**) that is intended to have physical existence in the real world and that has been used or instanced in a design.

NOTE Additionally, a Planned\_physical\_plant\_item is always intended to be 'physical' as opposed to purely volumetric. In general, this means that anything that would pose a hard physical impediment to a kick (e.g., a pump) is a physical item, and anything that does not (e.g., an escape route or the water in a cooling pond) is purely volumetric.

The data associated with a `Planned_physical_plant_item` are the following:

- `stock_code`;
- `global_unambiguous_identifier`.

#### **4.2.257.1 stock\_code**

The `stock_code` is an identifier of an in-stock item that may be necessary to be included in a piece of shop fabricated piping.

#### **4.2.257.2 global\_unambiguous\_identifier**

A `global_unambiguous_identifier` is a unique, persistent identifier of the item consisting of a concatenation of a `company_id` and a `local_id` generated by the company.

##### **4.2.257.2.1 company\_id**

The `company_id` specifies a unique identifier for the company that created the data. The string is left justified and blank filled.

##### **4.2.257.2.2 local\_id**

The `local_id` specifies a persistent identifier which uniquely identifies this item throughout the company. It is assigned at the time the item definition is created. The string is left justified and blank filled.

### **4.2.258. Plant**

A Plant is a portion of an installation (or the entire installation) required to operate to produce products. Each Plant may be one of the following: a `Manufacturing_line` (see **4.2.216**), a `Train` (see **4.2.356**), or a `Unit` (see **4.2.365**). The z-axis of the local coordinate system of the Plant shall be considered the elevation of the coordinate space.

NOTE `Manufacturing_lines` (see **4.2.216**), `Trains` (see **4.2.356**), and `Units` (see **4.2.365**), may be considered as sub-plants of a Plant because they perform all of the same functions as a plant and may be considered as a plant. They are distinct, they produce products based on input resources, and they are (relatively) independent of other plant/sub-plants. Trains, for instance, provide duplicate functionality of one another in case of failure.

The data associated with a Plant are the following:

- `definition_coordinate_system`;
- `description`;
- `length_between_perpendiculars`;
- `name`;
- `operator`;

- owners;
- plant\_id;
- plant\_type.

#### **4.2.258.1 definition\_coordinate\_system**

The `definition_coordinate_system` is the origin and axes of the Plant that serve as the basis for the location and orientation of `Plant_items` (see **4.2.260**) and subplants in the Plant.

#### **4.2.258.2 description**

The description specifies a textual explanation or summary of the Plant. The description need not be specified for a particular Plant. There may be more than one description for a Plant.

#### **4.2.258.3 length\_between\_perpendiculars**

`Length_between_perpendiculars` specifies the distance between perpendicular elements in the model. This is used to specify layout grids in a model, and to specify the horizontal, longitudinal distance between the aft and forward perpendiculars in ship models.

EXAMPLE Column spacing in a Plant is an example of layout grids in a model.

#### **4.2.258.4 name**

The name specifies a textual label given to the Plant.

#### **4.2.258.5 operator**

The operator specifies the name of the organization(s) responsible for the operation of the Plant. For a given Plant, the operator need not be specified.

#### **4.2.258.6 owners**

The owners specifies the name of the organization(s) that owns the Plant. For a given Plant, the owners need not be specified.

#### **4.2.258.7 plant\_id**

The `plant_id` specifies a unique identifier for the Plant. `Plant_id` is required for each Plant.

#### **4.2.258.8 plant\_type**

`Plant_type` specifies a designation that classifies a Plant based on its physical and functional characteristics.

EXAMPLE Examples of `plant_type` include: beverage plant, pharmaceutical plant, power plant, offshore oil facility, commercial ship, and military ship.

## 4.2.259. Plant\_csg\_shape\_representation

A Plant\_csg\_shape\_representation is a type of Shape\_representation (see 4.2.309). This requirement is for a "pure csg" shape, and a complex csg will be accomplished using the hybrid representation.

## 4.2.260. Plant\_item

A Plant\_item is an identifiable item that has a shape and that may be used as a component of the Plant (see 4.2.258). The Plant\_item need not be a physical item, but may be an allocation of space reserved for a purpose. Each Plant\_item is either: a Plant\_item\_definition (see 4.2.267) or a Plant\_item\_instance (see 4.2.269). Each Plant\_item may be one of the following: a Ducting\_component (see 4.2.90), an Electrical\_component (see 4.2.99), an Equipment (see 4.2.104), an Hvac\_component (see 4.2.145), an Instrumentation\_and\_control\_component (see 4.2.189), an Insulation (see 4.2.191), a Piping\_system\_component (see 4.2.250), a Structural\_component (see 4.2.335), or a Support\_component (see 4.2.343).

The data associated with a Plant\_item are the following:

- description;
- name;
- plant\_item\_id;
- status;
- type.

### 4.2.260.1 description

The description specifies a textual explanation or summary of the Plant\_item.

### 4.2.260.2 name

The name specifies a textual label given to the Plant\_item.

### 4.2.260.3 plant\_item\_id

The plant\_item\_id specifies a unique identifier for the Plant\_item. Plant\_item\_id is required for each Plant\_item.

### 4.2.260.4 status

The status specifies the state of the Plant\_item within the life cycle of the Plant (see 4.2.258).

### 4.2.260.5 type

The type specifies a designation that classifies a Plant\_item based on its physical and functional characteristics.

**4.2.261. Plant\_item\_centreline**

A `Plant_item_centreline` is a type of `Reference_geometry` (see **4.2.295**) that is a centre of symmetry of an aspect of the shape of the `Plant_item` (see **4.2.260**).

**4.2.262. Plant\_item\_collection**

A `Plant_item_collection` is an association that indicates that a component `Plant_item` (see **4.2.260**) is part of an aggregate `Plant_item`. Each `Plant_item_collection` may be a `Connected_collection` (see **4.2.70**). Each `Plant_item_collection` may be a `Hierarchically_organized_collection` (see **4.2.141**).

EXAMPLE A `Plant_item_collection` may be defined for a kit, where the members are not connected, or for an assembly, where the members are connected. Collections that are not hierarchically organized may be physical systems where a single component plays a role in multiple systems, such as a gauge.

The data associated with a `Plant_item_collection` are the following:

- `location_and_orientation`;
- `usage_type`.

**4.2.262.1 location\_and\_orientation**

The `location_and_orientation` specifies the relative position and orientation of the `Plant_item` (see **4.2.260**) within the `Plant_item_collection`. The `location_and_orientation` need not be specified for a particular `Plant_item_collection`.

**4.2.262.2 usage\_type**

The `usage_type` specifies the purpose for the association defined by the `Plant_item_collection`. The `usage_type` may be one of the following:

- BOM;
- compound bend pipe;
- source identification;
- assembly-component.

**4.2.262.2.1 BOM:** The value BOM specifies that the `Plant_item_collection` is being used to collect `Plant_items` (see **4.2.260**) that represent a bill of materials for the `Plant_item` identified as the group.

**4.2.262.2.2 compound bend pipe:** The value compound bend pipe specifies that the `Plant_item_collection` is being used to collect `Plant_items` (see **4.2.260**) that are Pipes (see **4.2.236**) to create a `Compound_bend_pipe` (see **4.2.65**). If the `usage_type` is `Compound_bend_pipe`, the group `Plant_item` shall be a `Compound_bend_pipe`, and the element `Plant_items` are either `Straight_pipe` (see **4.2.332**), `Swept_bend_pipe` (see **4.2.349**), or `Mitre_bend_pipe` (see **4.2.219**).

**4.2.262.2.3 source identification:** The value source identification specifies that the Plant\_item\_collection is being used to collect different suppliers' source Plant\_items (see 4.2.260) identified by the element for a particular Plant\_item identified by the group.

**4.2.262.2.4 assembly-component:** The value assembly-component specifies that the Plant\_item\_collection is being used to collect immediate component Plant\_items (see 4.2.260) in an assembly Plant\_item. The group identifies the Plant\_item that is the assembly and the element identifies the Plant\_item that is the group

## **4.2.263. Plant\_item\_connection**

A Plant\_item\_connection is a linkage between two or more Plant\_item\_connector (see 4.2.265) objects. The joining conditions may be specified for the connection. Each Plant\_item\_connection is either a Connection\_definition (see 4.2.72) or a Plant\_item\_connection\_occurrence (see 4.2.264). Each Plant\_item\_connection is either a Flexible\_connection (see 4.2.123) or a Locked\_orientation\_connection (see 4.2.213). Each Plant\_item\_connection may be an Electricity\_transference (see 4.2.102). Each Plant\_item\_connection may be a Fluid\_transference (see 4.2.124). Each Plant\_item\_connection may be a Load\_transference (see 4.2.209). Each Plant\_item\_connection can have many function types, for the purpose of describing the role that the connection plays in the Plant (see 4.2.258).

NOTE 1 In most cases, such as Piping\_components (see 4.2.240), a Plant\_item\_connection links only two Plant\_item\_connector (see 4.2.265) objects.

NOTE 2 The term connection does not imply functional continuity beyond the connectors involved in the connection.

The data associated with a Plant\_item\_connection are the following:

- connection\_commitment\_target;
- connection\_id;
- description;
- shop\_joint.

### **4.2.263.1 connection\_commitment\_target**

The connection\_commitment\_target specifies when in the life\_cycle phases of the Plant\_system (see 4.2.276) that a connection is actually made.

EXAMPLE Examples of connection\_commitment\_targets include fabrication, field-fit, commissioning, or others.

### **4.2.263.2 connection\_id**

The connection\_id specifies a unique identifier for the Plant\_item\_connection. Connection\_id is required for each Plant\_item\_connection.

### **4.2.263.3 description**

## **ISO/CD 10303-227**

The description specifies the textual explanation or summary of the function of the `Plant_item_connection`.

### **4.2.263.4 shop\_joint**

The `shop_joint` specifies that the connection is made in the shop.

## **4.2.264. Plant\_item\_connection\_occurrence**

A `Plant_item_connection_occurrence` is a type of `Plant_item_connection` (see **4.2.263**) that involves a physical linkage between two or more `Plant_item_connector_occurrence` (see **4.2.266**) objects.

The data associated with a `Plant_item_connection_occurrence` are the following:

- `connection_definition`;
- `field_fit`.

### **4.2.264.1 connection\_definition**

The `connection_definition` specifies the `connection_id` of the `Connection_definition` (see **4.2.72**) which specifies the defined characteristics of the `Plant_item_connection_occurrence`.

### **4.2.264.2 field\_fit**

The `field_fit` specifies that the `Plant_item_connection_occurrence` is to be made by adjusting the length of Pipe (see **4.2.236**) to make the connection properly.

## **4.2.265. Plant\_item\_connector**

A `Plant_item_connector` is a feature of a `Plant_item` (see **4.2.260**) that is designed to connect to a connector on another `Plant_item`. Each `Plant_item_connector` may have specified its design type as one of the following: an `Electrical_connector` (see **4.2.100**), a `Piping_connector` (see **4.2.242**), or a `Structural_load_connector` (see **4.2.336**). Each `Plant_item_connector` is either a `Connector_definition` (see **4.2.75**) (a definitional type) or a `Plant_item_connector_occurrence` (see **4.2.266**) (a specified type).

NOTE The definitional type is used as the connector definition for a `Plant_item_definition` (see **4.2.267**). A specified type is used for a `Plant_item_instance` (see **4.2.269**).

The data associated with a `Plant_item_connector` are the following:

- `connect_point`;
- `plant_item_connector_id`.

### **4.2.265.1 connect\_point**

The `connect_point` specifies a point on or in the connector where the terminal interface with another connector occurs.

#### **4.2.265.2 `plant_item_connector_id`**

The `plant_item_connector_id` specifies a unique identifier for the `Plant_item_connector`. `Plant_item_connector_id` is required for each `Plant_item_connector`.

### **4.2.266. `Plant_item_connector_occurrence`**

A `Plant_item_connector_occurrence` is a type of `Plant_item_connector` (see **4.2.265**) that is a physical feature of a `Plant_item` (see **4.2.260**) that connects or mates with a like type of connector on another `Plant_item`. Each `Plant_item_connector_occurrence` is either: a `Functional_connector` (see **4.2.128**) or a `Physical_connector` (see **4.2.234**).

The data associated with a `Plant_item_connector_occurrence` are the following:

- `connector_definition`;
- `orientation`.

#### **4.2.266.1 `connector_definition`**

The `connector_definition` specifies the `connector_id` of the `Connector_definition` (see **4.2.75**) which specifies the defined characteristics of the `Plant_item_connector_occurrence`.

#### **4.2.266.2 `orientation`**

The `orientation` specifies the relative orientation of the `Plant_item_connector_occurrence` to a defined point on the `Plant_item` (see **4.2.260**).

### **4.2.267. `Plant_item_definition`**

A `Plant_item_definition` is a type of `Plant_item` (see **4.2.260**) that has been designed to some level of completeness, but has not been used as the design for physical `Plant_item` objects.

### **4.2.268. `Plant_item_design_view`**

A `Plant_item_design_view` is the collection of information about a `Plant_item` (see **4.2.260**) that is associated with a particular design phase. Each `Plant_item_design_view` is either: a `Functional_design_view` (see **4.2.131**) or a `Physical_design_view` (see **4.2.235**).

### **4.2.269. `Plant_item_instance`**

A `Plant_item_instance` is a planned type of `Plant_item` (see **4.2.260**), as instanced in a spatial, functional or other design. Each `Plant_item_instance` is either a `Planned_physical_plant_item` (see **4.2.257**) or a `Plant_volume` (see **4.2.278**).

NOTE A `Plant_item_instance` is created through the use or instancing of a `Plant_item_definition` (see **4.2.267**) by placing it in a design.

## **4.2.270. Plant\_item\_interference**

A `Plant_item_interference` is where the spatial volume occupied by a `Plant_item` (see **4.2.260**) overlaps the space occupied by one or more `Plant_item` objects.

The data associated with a `Plant_item_interference` are the following:

- `interference_id`;
- `type`.

### **4.2.270.1 interference\_id**

The `interference_id` specifies an identifier for the `Plant_item_interference`.

### **4.2.270.2 type**

The `type` specifies the classification assigned to the `Plant_item_interference` based on the criticality of the clash.

NOTE The criticality is an assessment of the importance or significance of the clash for a particular project. The values are project dependent.

## **4.2.271. Plant\_item\_interference\_status**

A `Plant_item_interference_status` is a designation indicating the state of resolution of an identified interference.

The data associated with a `Plant_item_interference_status` are the following:

- `assessor`;
- `first_item`;
- `second_item`;
- `status`.

### **4.2.271.1 assessor**

The `assessor` specifies the individual or organization assigned the responsibility for resolving the `Plant_item_interference` (see **4.2.270**).

### **4.2.271.2 first\_item**

The `first_item` specifies the `plant_item_id` of one of the `Plant_items` (see **4.2.260**) that is interfering.

### **4.2.271.3 second\_item**

The `second_item` specifies the `plant_item_id` of one of the `Plant_items` (see **4.2.260**) that is interfering.

#### **4.2.271.4 status**

The status specifies a designation indicating the state of resolution of an identified `Plant_item_interference` (see **4.2.270**).

### **4.2.272. Plant\_item\_location**

A `Plant_item_location` is the position of the `Plant_item` (see **4.2.260**) within a `Plant` (see **4.2.258**). The position of a `Plant_item` is specified as the transformation (translation and rotation) of a point and axes on the `Plant_item` to a point and axes in the destination coordinate system. Each `Plant_item_location` is either a `Location_in_building` (see **4.2.210**), a `Location_in_plant` (see **4.2.211**), a `Location_in_site` (see **4.2.212**), or a `Relative_item_location` (see **4.2.298**).

The data associated with a `Plant_item_location` are the following:

- `location_and_orientation`;
- `location_id`.

#### **4.2.272.1 location\_and\_orientation**

The `location_and_orientation` specifies the relative position and orientation of the `Plant_item` (see **4.2.260**) within the `Plant` (see **4.2.258**).

#### **4.2.272.2 location\_id**

The `location_id` specifies a unique identifier for the `Plant_item_location`.

### **4.2.273. Plant\_item\_shape**

A `Plant_item_shape` is the volumetric representation of a `Plant_item` (see **4.2.260**). Each `Plant_item_shape` may be one of the following: a `Detail_shape` (see **4.2.88**), an `Envelope_shape` (see **4.2.103**), or an `Outline_shape` (see **4.2.228**). The z-axis of the local coordinate system of the `Plant_item_shape` shall be considered the elevation of the coordinate space.

The data associated with a `Plant_item_shape` are the following:

- `clash_detection_class`;
- `origin`.

#### **4.2.273.1 clash\_detection\_class**

The `clash_detection_class` specifies a designation that classifies a `Plant_item_shape` for the purposes of interference checking. The value of the `clash_detection_class` attribute shall be one of the following:

- `hard`;
- `ignore`;

— soft.

**4.2.273.1.1 hard:** the `Plant_item_shape` is used for clash detection and indicates that the shape cannot occupy the same physical space with another hard shape.

**4.2.273.1.2 ignore:** the `Plant_item_shape` is not used for clash detection.

**4.2.273.1.3 soft:** the `Plant_item_shape` is used for clash detection and indicates that the shape can occupy the same space with another soft shape and, depending on the circumstances, may occupy the same space as a hard object.

NOTE See Table 1. Table 1 represents a comparison between the `clash_detection_class` designations for two `Plant_item_shapes` and indicates whether the resulting interference would be designated as hard clash, soft clash, or no clash. A hard clash refers to an interference between two `Plant_item_shapes` whose `clash_detection_class` is hard. A soft clash refers to an interference between two `Plant_item_shapes` where at least one of the `Plant_item_shapes` has a `clash_detection_class` of soft. A no clash refers to an interference between two `Plant_item_shapes` where at least one of the `Plant_item_shapes` has a `clash_detection_class` of ignore.

**Table 1 — `Plant_item_shape` interference clash detection**

	Hard	Ignore	Soft
Hard	hard clash	no clash	soft clash
Ignore	no clash	no clash	no clash
Soft	soft clash	no clash	soft clash

#### **4.2.273.2 origin**

The origin specifies the locating point for the geometric shape of a `Plant_item` (see **4.2.260**).

### **4.2.274. `Plant_item_weight`**

A `Plant_item_weight` is an estimate or the measure of the force experienced by the `Plant_item` (see **4.2.260**) as a result of the earth's gravity.

NOTE Before the `Plant_item` (see **4.2.260**) actually exists, weight is simply an estimate. The actual weight may be provided if the `Plant_item` does exist and has been measured.

The data associated with a `Plant_item_weight` are the following:

- `centre_of_gravity`;
- `weight_state`;
- `weight_value`.

**4.2.274.1 centre\_of\_gravity**

The `centre_of_gravity` specifies the point where the entire weight of a `Plant_item` (see **4.2.260**) may be considered as concentrated so that if supported at this point the `Plant_item` would remain in equilibrium in any position.

**4.2.274.2 weight\_state**

The `weight_state` specifies a designation of the condition of the `Plant_item` (see **4.2.260**) that corresponds to the `Plant_item_weight`.

NOTE The value of the `weight_state` may be one of a set of predefined values or may be user supplied.

The value of the `weight_state` attribute may be one of the following:

- empty;
- full;
- operating;
- shipping;
- test;
- weight value.

**4.2.274.2.1 empty:** the `Plant_item` (see **4.2.260**) does not contain any process materials.

**4.2.274.2.2 full:** the `Plant_item` (see **4.2.260**) contains maximum amount of process materials.

**4.2.274.2.3 operating:** the `Plant_item` (see **4.2.260**) is in normal operating conditions.

**4.2.274.2.4 shipping:** the `Plant_item` (see **4.2.260**) and its transportation and packing materials are included.

**4.2.274.2.5 test:** the `Plant_item` (see **4.2.260**) is for purposes of structural load calculations.

**4.2.274.3 weight\_value**

The `weight_value` specifies a measure of the force experienced by the `Plant_item` (see **4.2.260**) as a result of the earth's gravity.

**4.2.275. Plant\_process\_capability**

A `Plant_process_capability` is a functional behaviour that can be executed by the `Plant` (see **4.2.258**).

The data associated with a `Plant_process_capability` are the following:

- `production_capacity`;
- `production_type`.

EXAMPLE A Plant (see **4.2.258**) with a production\_type of POWER may produce power at a production\_capacity of 500 million kilowatts per hour. If this process capability is provided by a combination of a Piping\_system (see **4.2.249**) (for steam, for example) and an Electrical\_system (see **4.2.101**), both of these systems can be combined as a subplant; the subplant has the process capability and is part of a plant.

#### **4.2.275.1 production\_capacity**

The production\_capacity specifies the rated output of the Plant (see **4.2.258**) with respect to a Plant\_process\_capability.

#### **4.2.275.2 production\_type**

The production\_type specifies a designation that classifies the Plant (see **4.2.258**) based on the products it produces.

### **4.2.276. Plant\_system**

A Plant\_system is a combination of Plant\_item (see **4.2.260**) objects that perform a function required for the Plant (see **4.2.258**) to operate to produce products. Each Plant\_system may be one of the following: an Electrical\_system (see **4.2.101**), a Ducting\_system (see **4.2.91**), an Instrumentation\_and\_control\_system (see **4.2.190**), a Piping\_system (see **4.2.249**), or a Structural\_system (see **4.2.337**).

The data associated with a Plant\_system are the following:

- name;
- plant\_system\_id;
- service\_description;
- approval\_state.

#### **4.2.276.1 name**

The name specifies a textual label given to the Plant\_system.

#### **4.2.276.2 plant\_system\_id**

The plant\_system\_id specifies a unique identifier for the Plant\_system. Plant\_system\_id is required for each Plant\_system.

#### **4.2.276.3 service\_description**

The service\_description specifies a textual or summary label for the system.

EXAMPLE Examples of service\_description labels include Boiler Feedwater System, Paraxylene System, Pipe Rack K, and 4160V Power System.

#### **4.2.276.4 approval\_state**

The approval\_state indicates the current status of the system.

#### **4.2.277. Plant\_system\_assembly**

A Plant\_system\_assembly is a collection of Plant\_system (see **4.2.276**) objects into a higher-level system to perform a functional capability.

The data associated with a Plant\_system\_assembly are the following:

- subsystem;
- supersystem.

##### **4.2.277.1 subsystem**

The subsystem specifies the plant\_id and plant\_system\_id of the Plant\_system (see **4.2.276**) that is the component system in the Plant\_system\_assembly.

##### **4.2.277.2 supersystem**

The supersystem specifies the plant\_id and plant\_system\_id of the Plant\_system (see **4.2.276**) that is the assembly system in the Plant\_system\_assembly.

#### **4.2.278. Plant\_volume**

A Plant\_volume is a type of Plant\_item\_instance (see **4.2.269**) that is a specifically defined volume located within a Plant (see **4.2.258**) that may, but need not be occupied by physical Plant\_item (see **4.2.260**) objects. Each Plant\_volume may be one of the following: a Reserved\_space (see **4.2.300**), a Route (see **4.2.302**), or a System\_space (see **4.2.350**).

The data associated with a Plant\_volume are the following:

- type.

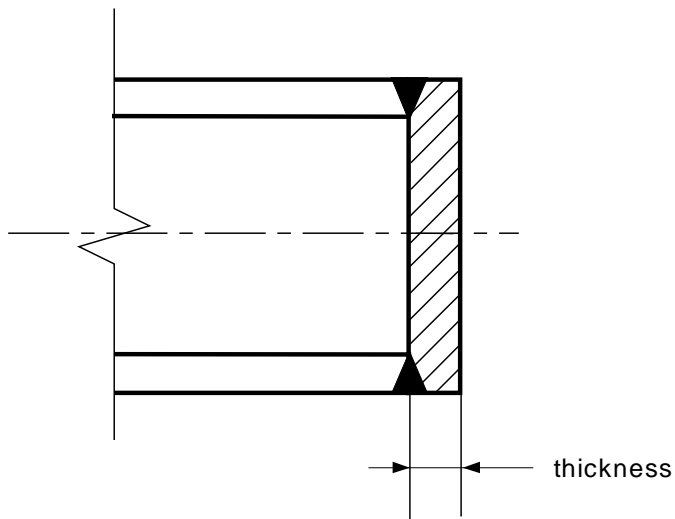
The type specifies a designation that classifies the Plant\_volume.

EXAMPLE Examples of Plant\_volume object type classifications include reserved space, zone-area, area classification zone, equipment pull space, and egress for personnel.

#### **4.2.279. Plate**

A Plate is a type of Pipe\_closure (see **4.2.237**) that consists of a flat piece that is welded on the end of the Pipe (see **4.2.236**).

NOTE Figure 50 depicts a typical Plate.



**Figure 50 - Plate**

The data associated with a Plate are the following:

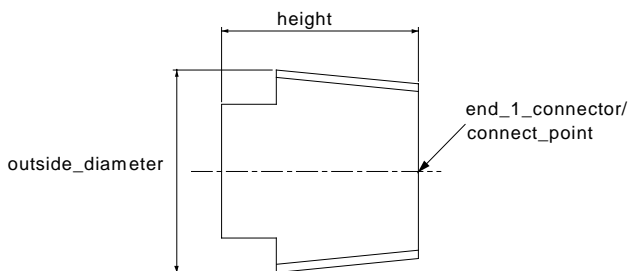
— thickness.

The thickness is the distance between the parallel faces of the Plate.

#### **4.2.280. Plug**

A Plug is a type of Pipe\_closure (see **4.2.237**) that closes off the end of a Pipe (see **4.2.236**) by fitting within the inside wall of the Pipe.

NOTE Figure 51 depicts a typical Plug.



**Figure 51 - Plug**

The data associated with a Plug are the following:

— height.

The height specifies the axial length of Plug.

### 4.2.281. Point

A Point is a type of Wire\_and\_surface\_element (see 4.2.372) that is a dimensionless location in space.

### 4.2.282. Point\_and\_line\_representation

A Point\_and\_line\_representation is a type of Site\_shape\_representation (see 4.2.315) represented as a collection of Point (see 4.2.281) objects that define the surface grid of the topography of a Site (see 4.2.313).

### 4.2.283. Polygon

A Polygon is a type of Curve (see 4.2.85) that is composed of a set of points connected by line segments that form a planar, closed, non-self-intersecting figure.

### 4.2.284. Pressure\_class

A Pressure\_class is a type of Piping\_size\_description (see 4.2.244) based on pressure rating or classification and a nominal size value.

NOTE This type of Piping\_size\_description (see 4.2.244) is commonly associated with a dimensional specification, such as the ANSI B16.5 specification for Flange objects.

The data associated with a Pressure\_class are the following:

- nominal\_size;
- pressure\_rating.

#### 4.2.284.1 nominal\_size

The nominal\_size specifies a standard size designation of the Piping\_system\_component (see 4.2.250) or Piping\_connector (see 4.2.242). It may be specified as a single value or as a range of values.

NOTE 1 The nominal size need not represent an actual dimension.

NOTE 2 See annex L for a discussion of attributes that may be assigned a single value or a range of values.

#### 4.2.284.2 pressure\_rating

The pressure\_rating specifies a nominal pressure for the design of the Piping\_system\_component (see 4.2.250) or Piping\_connector (see 4.2.242). It may be specified as a single value or as a range of values.

NOTE 1 When specified with a dimensional standard, such as ANSI B16.1, its value corresponds to a selection out of a set of available values (e.g., 150 PSI, 300 PSI).

NOTE 2 See annex L for a discussion of attributes that may be assigned a single value or a range of values.

### 4.2.285. Pressure\_fit

A Pressure\_fit is a type of Piping\_connector (see 4.2.242) that is a physical feature of a Plant\_item (see 4.2.260) that intended to establish a connection with another connector through pressure between the connector rather than by means of threading, welds, or fasteners.

#### **4.2.286.      Process\_ducting**

A Process\_ducting is a type of Ducting\_component (see 4.2.90) and Piping\_system\_component (see 4.2.250) that consists of Piping\_component (see 4.2.240) objects or ductwork that is used to convey process streams in a Plant (see 4.2.258).

NOTE Process\_ducting is used for venting gaseous portions of the process stream. It is part of the system that handles the process stream, but is ductwork rather than piping.

The data associated with a Process\_ducting are the following:

— gauge.

The gauge specifies a designation that refers to the thickness of the Process\_ducting.

#### **4.2.287.      Project\_design\_assignment**

A Project\_design\_assignment is an assignment of a Plant\_item (see 4.2.260) to a Design\_project (see 4.2.87).

NOTE The set of Project\_design\_assignment instances for a project defines the items and areas that are part of the project.

#### **4.2.288.      Pyramid**

A Pyramid is a type of Csg\_element (see 4.2.84) that is a 3D volume with a rectangular base and four triangular sides that meet at an apex. The axis of a Pyramid is the line segment from the centre of the base to the apex.

#### **4.2.289.      Raceway**

A Raceway is a type of Cableway\_piece (see 4.2.22) that has a rectangular cross section and contains one or more channels for holding cables.

EXAMPLE Surface raceway, ladder-type raceway.

#### **4.2.290.      Raceway\_lane**

A Raceway\_lane is a type of Cableway\_component (see 4.2.19) that is a channel within a Raceway (see 4.2.289) for holding cables.

#### **4.2.291.      Raceway\_size\_description**

A `Raceway_size_description` is a type of `Cableway_size_description` (see **4.2.23**) that is used to explain or summarize the physical size of a Raceway (see **4.2.289**) based on a set of dimensional characteristics.

The data associated with a `Raceway_size_description` are the following:

- `outer_width`;
- `outer_height`;
- `inner_width`;
- `inner_height`.

#### **4.2.291.1 `outer_width`**

The `outer_width` is the horizontal measurement of the outer surface of a Raceway (see **4.2.289**). It may be specified as a single value or as a range of values.

NOTE See annex L for a discussion of attributes that may be assigned a single value or a range of values.

#### **4.2.291.2 `outer_height`**

The `outer_height` is the vertical measurement of the outer surface of a Raceway (see **4.2.289**). It may be specified as a single value or as a range of values.

NOTE See annex L for a discussion of attributes that may be assigned a single value or a range of values.

#### **4.2.291.3 `inner_width`**

The `inner_width` is the horizontal measurement of the inner surface of a Raceway (see **4.2.289**). It may be specified as a single value or as a range of values.

NOTE See annex L for a discussion of attributes that may be assigned a single value or a range of values.

#### **4.2.291.4 `inner_height`**

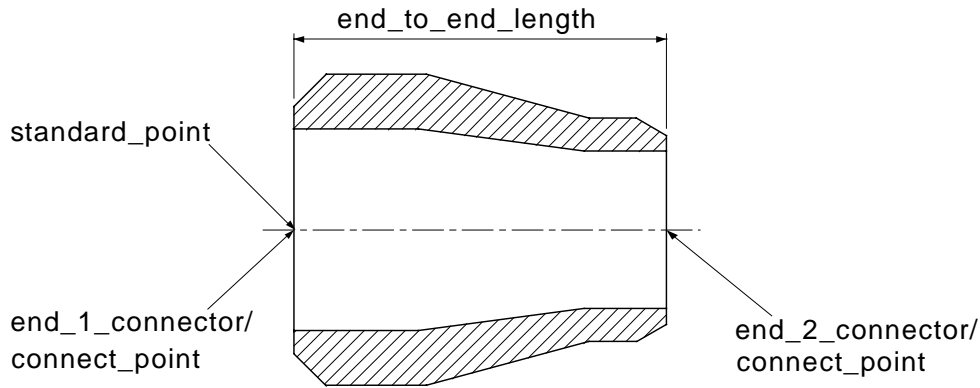
The `inner_height` is the vertical measurement of the inner surface of a Raceway (see **4.2.289**). It may be specified as a single value or as a range of values.

NOTE See annex L for a discussion of attributes that may be assigned a single value or a range of values.

### **4.2.292. Reducer**

A Reducer is a type of Fitting (see **4.2.118**) that provides a reduction from one Pipe (see **4.2.236**) size to another. Each Reducer may be an `Eccentric_reducer` (see **4.2.97**).

NOTE Figure 52 depicts a typical butt-weld Reducer.



**Figure 52 - Reducer**

The data associated with a Reducer are the following:

- end\_1\_connector;
- end\_2\_connector;
- end\_to\_end\_length.

#### **4.2.292.1 end\_1\_connector**

The end\_1\_connector specifies the Piping\_connector (see **4.2.242**) that connects to the larger size Pipe (see **4.2.236**).

#### **4.2.292.2 end\_2\_connector**

The end\_2\_connector specifies the Piping\_connector (see **4.2.242**) that connects to the smaller size Pipe (see **4.2.236**).

#### **4.2.292.3 end\_to\_end\_length**

The end\_to\_end\_length specifies the external distance between the end-one face and the end-two face of the Reducer. It may be specified as a single value or as a range of values.

NOTE 1 See annex L for a discussion of attributes that may be assigned a single value or a range of values.

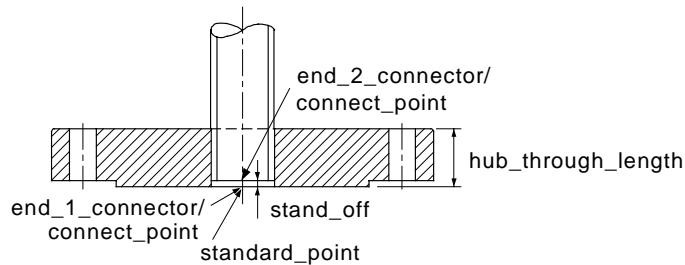
NOTE 2 Swage is a synonym for Reducer which is normally used for smaller sizes.

### **4.2.293. Reducing\_flange**

A Reducing\_flange is a type of Flange (see **4.2.119**) used to make a Flanged (see **4.2.120**) joint between Pipe (see **4.2.236**) objects of different nominal sizes that has the dimensional characteristics of the larger Pipe and the bore of the smaller Pipe.

EXAMPLE Examples of Reducing\_flange types include Weld\_neck\_flange (see 4.2.370), Slip\_on\_flange (see 4.2.317), Socket\_weld\_flange (see 4.2.320), and Threaded\_flange (see 4.2.353).

NOTE Figure 53 depicts a typical Reducing\_flange.



**Figure 53 - Reducing\_flange**

The data associated with a Reducing\_flange are the following:

— stand\_off.

The stand\_off specifies the measure of the distance between the face of the Reducing\_flange and the end of the Pipe (see 4.2.236) that is inserted into the Reducing\_flange. It may be specified as a single value or as a range of values.

NOTE See annex L for a discussion of attributes that may be assigned a single value or a range of values.

#### 4.2.294. Reducing\_torus

A Reducing\_torus is a type of Csg\_element (see 4.2.84) that is formed by sweeping a circle that uniformly decreases in size through a circular sweep angle of less than 360 degrees.

#### 4.2.295. Reference\_geometry

A Reference\_geometry is the identification of one or more Shape\_representation\_element (see 4.2.310) objects in a model that are not part of a component shape, but provide additional geometric information relative to the shape of the Plant\_item (see 4.2.260). Each Reference\_geometry may be a Plant\_item\_centreline (see 4.2.261).

The data associated with a Reference\_geometry are the following:

— name.

The name specifies a textual label given to the Reference\_geometry.

#### 4.2.296. Reinforcing\_component

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A Reinforcing\_component is a type of Piping\_component (see **4.2.240**) which is used to strengthen the Piping\_spool (see **4.2.246**).

The data associated with a Reinforcing\_component are the following:

- end\_1\_connector;
- location\_point;
- orientation.

### 4.2.296.1 end\_1\_connector

The end\_1\_connector specifies the Piping\_connector (see **4.2.242**) on the Reinforcing\_component to the pipe.

### 4.2.296.2 location\_point

The location\_point is a standard point on Piping\_component (see **4.2.240**) at which the Reinforcing\_component is attached.

### 4.2.296.3 orientation

The orientation specifies a unit vector in the direction perpendicular to the centreline of the run pipe. The vector defines the layout of the Reinforcing\_component.

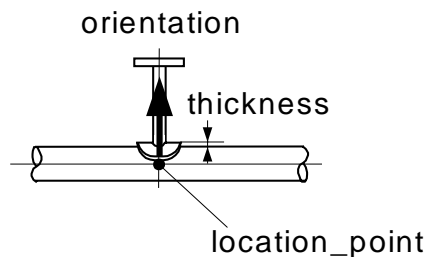
### 4.2.296.4 reinforcing component types

Necessary information for piping shop fabrication: type, location point, orientation and dimensional parameters. Types of Reinforcing\_components include: Gusset (see **4.2.138**), Reinforcing\_plate (see **4.2.297**), and Stay (see **4.2.330**).

## 4.2.297. Reinforcing\_plate

A Reinforcing\_plate is a type of Reinforcing\_component (see **4.2.296**) that is made of plate that has a hole at its centre. It is firmly attached to run pipe and branch pipe to prevent the welded part between the branch pipe and the run pipe from breaking.

NOTE Figure 54 depicts a typical Reinforcing\_plate.



**Figure 54 - Reinforcing\_plate**

The data associated with a Reinforcing\_plate are the following:

— thickness.

The thickness is the distance of the top face of the Reinforcing\_plate from the surface of the run pipe.

#### **4.2.298. Relative\_item\_location**

A Relative\_item\_location is a type of Plant\_item\_location (see 4.2.272) that is the relative position of the Plant\_item (see 4.2.260) with respect to another Plant\_item.

#### **4.2.299. Required\_material\_description**

A Required\_material\_description is a specification of the substances or the requirements of the substances that a component is to be made from.

The data associated with a Required\_material\_description are the following:

— description;

— material\_requirement\_id.

##### **4.2.299.1 description**

The description specifies a textual explanation or summary of the required materials.

##### **4.2.299.2 material\_requirement\_id**

The material\_requirement\_id specifies a unique identifier for the specification that provides the required material. Material\_requirement\_id is required for each Required\_material\_description.

NOTE The identifier is normally a coded value that is company-specific.

#### **4.2.300. Reserved\_space**

A Reserved\_space is a type of Plant\_volume (see 4.2.278) that is a region of space that is not to be obstructed by physical objects for reasons related to plant operation.

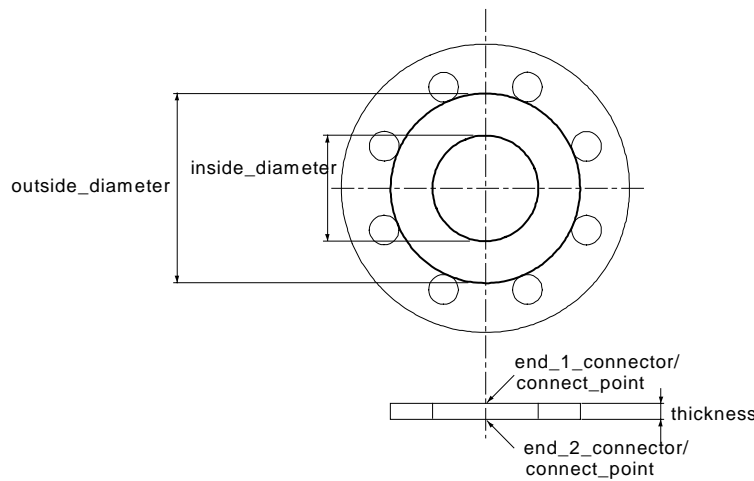
NOTE Reserved\_spaces are normally prescriptive.

EXAMPLE Reserved\_spaces include maintenance volume, operator access, and safety zone.

#### **4.2.301. Ring\_spacer**

A Ring\_spacer is a type of Spacer (see 4.2.322) that fits between Flange (see 4.2.119) objects in a Flanged (see 4.2.120) joint to bridge a large gap or fill a slight angle between the Flange objects that cannot be accommodated by standard Flange gaskets.

NOTE Figure 55 depicts a typical Ring\_spacer.



**Figure 55 - Ring\_spacer**

The data associated with a Ring\_spacer are the following:

— inside\_diameter.

The inside\_diameter specifies the diameter of the bore hole through the Ring\_spacer. It may be specified as a single value or as a range of values.

NOTE See annex L for a discussion of attributes that may be assigned a single value or a range of values.

## 4.2.302. Route

A Route is a type of Plant\_volume (see 4.2.278) that is a 3D path from one location to another.

NOTE 1 A Route is a conceptual engineered path that reserves space for a Piping\_system (see 4.2.249). This space need not be occupied by a Plant\_item (see 4.2.260) at a future time.

NOTE 2 The shape of the reserved volume of a Route is a specified Plant\_item\_shape (see 4.2.273).

EXAMPLE A cable trench is a kind of Route that goes through and runs underneath the surface of a Site (see 4.2.313).

## 4.2.303. Schedule

A Schedule is a type of Piping\_size\_description (see 4.2.244) that gives the Pipe (see 4.2.236) or Piping\_component (see 4.2.240) size in terms of nominal size and a sizing schedule.

NOTE When a Schedule entity is used, the dimensional standard attribute of Piping\_size\_description (see 4.2.244) must be specified.

The data associated with a Schedule are the following:

— nominal\_size;

— pipe\_schedule.

### 4.2.303.1 nominal\_size

The `nominal_size` specifies a standard size designation of the `Piping_system_component` (see **4.2.250**) or `Piping_connector` (see **4.2.242**). It may be specified as a single value or as a range of values.

NOTE 1 The nominal size need not represent an actual dimension.

NOTE 2 See annex L for a discussion of attributes that may be assigned a single value or a range of values.

#### **4.2.303.2 pipe\_schedule**

The `pipe_schedule` specifies a designation of a standard wall thickness and external diameter for a nominal pipe size through a reference to the dimensional standard.

### **4.2.304. Segment\_insulation**

A `Segment_insulation` is a logical connection between a `Piping_system_line_segment` (see **4.2.252**) and the `Insulation` (see **4.2.191**) attached to the `Pipe` (see **4.2.236**) associated with the `Piping_system_line_segment`.

The data associated with a `Segment_insulation` are the following:

- boundaries;
- description;
- line\_number;
- thickness;
- type.

#### **4.2.304.1 boundaries**

The `boundaries` specifies a description that defines the boundaries for `Insulation` (see **4.2.191**) on the `Piping_system_line` (see **4.2.251**).

EXAMPLE An example description for the `Insulation` (see **4.2.191**) boundaries of a `Piping_system_line` (see **4.2.251**) is personnel protection insulation shall extend to 12 feet above grade or walkway.

#### **4.2.304.2 description**

The `description` specifies a textual explanation or summary of the reasons for providing `Insulation` (see **4.2.191**).

EXAMPLE Examples of `Piping_system_line` (see **4.2.251**) `Insulation` (see **4.2.191**) descriptions include provided for heat conservation and provided for personnel protection.

#### **4.2.304.3 line\_number**

The `line_number` specifies an alphanumeric identifier assigned to the `Piping_system_line` (see **4.2.251**) and can be used to uniquely define the `Piping_system_line`. `Line_number` is required for each `Piping_system_line`.

The thickness specifies the distance between the inside and outside surfaces of the Insulation (see **4.2.191**). It may be specified as a single value or as a range of values.

NOTE See annex L for a discussion of attributes that may be assigned a single value or a range of values. The thickness of the insulation may vary over the extent of the insulation.

**4.2.304.5 type**

The type specifies the Insulation (see **4.2.191**) material.

**4.2.305. Service\_operating\_case**

A Service\_operating\_case is a stream condition that may exist at a Plant\_item\_connector (see **4.2.265**).

EXAMPLE Examples of Service\_operating\_case conditions include normal, upset, and shutdown.

The data associated with a Service\_operating\_case are the following:

- duration;
- frequency;
- name;
- operating\_pressure;
- operating\_temperature.

**4.2.305.1 duration**

The duration specifies the expected time span of the Service\_operating\_case. It may be specified as a single value or as a range of values.

NOTE See annex L for a discussion of attributes that may be assigned a single value or a range of values.

**4.2.305.2 frequency**

The frequency specifies the expected number of times that the Service\_operating\_case will occur over a defined period of time. It may be specified as a single value or as a range of values.

NOTE See annex L for a discussion of attributes that may be assigned a single value or a range of values.

**4.2.305.3 name**

The name specifies a textual label given to the condition that the Equipment (see **4.2.104**) operating characteristics are being defined under.

**4.2.305.4 operating\_pressure**

The `operating_pressure` specifies the force per unit area exerted by the process stream on the `Plant_item` (see **4.2.260**) under a specific `Service_operating_case`. It may be specified as a single value or as a range of values.

NOTE See annex L for a discussion of attributes that may be assigned a single value or a range of values.

#### **4.2.305.5 `operating_temperature`**

The `operating_temperature` specifies the temperature of the process stream on the `Plant_item` (see **4.2.260**) under a specific `Service_operating_case`. It may be specified as a single value or as a range of values.

NOTE See annex L for a discussion of attributes that may be assigned a single value or a range of values.

### **4.2.306. `Shape_inspection_record`**

A `Shape_inspection_record` is a collection of information that captures the result of an evaluation of an observed value for a characteristic of the shape of a `Piping_spool` (see **4.2.246**) against an expected, designed or prescribed value for that characteristic, as well as information to evaluate the acceptability of the observed value.

The data associated with a `Shape_inspection_record` are the following:

- `shape_inspection_property_name`;
- `shape_inspection_property_sequence_number`;
- `inspected_property_tolerance`;
- `inspected_property_measured_value`.

#### **4.2.306.1 `shape_inspection_property_name`**

The `shape_inspection_property_name` specifies the characteristic for which information is being recorded. The `shape_inspection_property_name` may be one of the following:

- point to point length;
- point to point angle;
- planarity;
- attached element location;
- attached element orientation.

#### **4.2.306.2 `shape_inspection_property_sequence_number`**

The `shape_inspection_property_sequence_number` specifies an alphanumeric string that identifies the node point that defines the shape property that is being measured. There may be more than one `shape_inspection_property_sequence_number` for a `Shape_inspection_record`.

NOTE The method of identification is outside the scope of this part of ISO 10303.

#### **4.2.306.3 `inspected_property_tolerance`**

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The `inspected_property_tolerance` specifies the acceptable deviation for the measured result of the inspection.

### **4.2.306.4 `inspected_property_measured_value`**

The `inspected_property_measured_value` specifies the recorded result of the inspection.

## **4.2.307. Shape\_interference\_zone\_usage**

A `Shape_interference_zone_usage` is the representational elements that define the shape of a volume that encloses the region of space where the interference of clashing `Plant_items` (see **4.2.260**) occurs.

The data associated with a `Shape_interference_zone_usage` are the following

- `first_item`;
- `second_item`.

### **4.2.307.1 `first_item`**

The `first_item` specifies the `plant_item_id` of one of the `Plant_items` (see **4.2.260**) that is interfering.

### **4.2.307.2 `second_item`**

The `second_item` specifies the `plant_item_id` of one of the `Plant_items` (see **4.2.260**) that is interfering.

## **4.2.308. Shape\_parameter**

A `Shape_parameter` is a type of `Shape_representation_element` (see **4.2.310**) that is a name-value pair that specifies the dimensional value of some aspect of the `Plant_item_shape` (see **4.2.273**). The meaning of the name-value pair is not specified in this part of ISO 10303.

NOTE 1 A use of this structure is to provide a generic capability to reference classes of `Plant_items` (see **4.2.260**) by a dimensional characteristic, such as 5 centimeter pipe.

NOTE 2 It was not the intent of this object to use this structure to create a geometric representation of an item. The effective use of this structure requires an agreement between the exchanging parties as to the meanings of the names so that they can understand the information being exchanged.

The data associated with a `Shape_parameter` are the following:

- `name`;
- `value`.

### **4.2.308.1 `name`**

The name specifies a textual label given to a dimension or parameter of a Plant\_item\_shape (see 4.2.273).

EXAMPLE An example of this is the name "diameter".

#### 4.2.308.2 value

The value specifies a number that represents the measure of the dimension or parameter of the Plant\_item\_shape (see 4.2.273).

EXAMPLE An example of this is the value "5.6".

### 4.2.309. Shape\_representation

A Shape\_representation is a combination of geometric elements that describe or define the general or specific surface boundaries of a Plant\_item (see 4.2.260). Shape\_representation is either a Hybrid\_shape\_representation (see 4.2.181) or Plant\_csg\_shape\_representation (see 4.2.259).

NOTE Shape representation need not be the exact or specific shape of the item.

### 4.2.310. Shape\_representation\_element

A Shape\_representation\_element is a geometric model that is used to represent the shape or some aspect of the shape of a Plant\_item (see 4.2.260). Each Shape\_representation\_element is either a B\_rep\_element (see 4.2.2), a Csg\_element (see 4.2.84), a Shape\_parameter (see 4.2.308), or a Wire\_and\_surface\_element (see 4.2.372).

### 4.2.311. Shape\_representation\_element\_usage

A Shape\_representation\_element\_usage is an assignment of a Shape\_representation\_element (see 4.2.310) to a Shape\_representation (see 4.2.309) of a Plant\_item (see 4.2.260).

NOTE Shape\_representation\_element\_usage is the mechanism that aggregates the geometric elements that represent the shape of the Plant\_item (see 4.2.260). The rules are constraints for what constitutes a valid aggregation are delineated by conformance class.

The data associated with a Shape\_representation\_element\_usage are the following:

— element\_colour;

— layer.

#### 4.2.311.1 element\_colour

The element\_colour specifies the colour that displays the element.

#### 4.2.311.2 layer

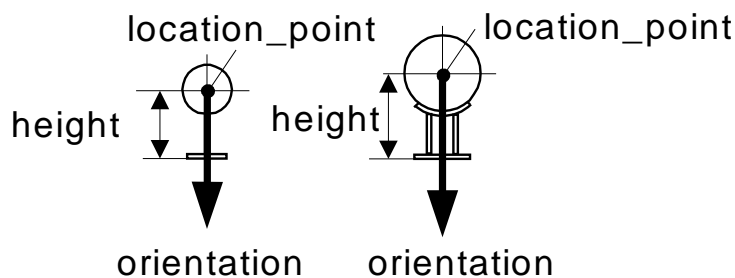
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The layer specifies the collection of displayable items for the purpose of controlling visibility and presentation style.

### 4.2.312. Shoe

A Shoe is a type of Piping\_support (see 4.2.248) that is composed of Plates (see 4.2.279), and which has a cross-sectional shape that resembles a reversed “T” or reversed PI. The Shoe supports the weight rigidly at its base, and is used to regulate the movement or to fix the position of pipe.

NOTE Figure 56 depicts a typical Shoe.



**Figure 56 - Shoe**

The data associated with a Shoe are the following:

— height.

The height is the distance between the supporting face of the base plate of the Shoe and location\_point.

### 4.2.313. Site

A Site is a geographical location where the Plant (see 4.2.258) is located. The z-axis of the local coordinate system of the Site shall be considered the elevation of the coordinate space.

The data associated with a Site are the following:

— address;

— coordinates;

— elevation;

— environmental\_references;

— locality;

- name;
- orientation;
- owners;
- site\_id.

#### **4.2.313.1 address**

The address specifies the street address (including city, state, and zip code as appropriate) of the Site.

#### **4.2.313.2 coordinates**

The coordinates specifies the longitude and latitude coordinates of the Site with respect to a known Point (see **4.2.281**) on the Site.

#### **4.2.313.3 elevation**

The elevation specifies the distance that the Site is located above sea level with respect to a known Point (see **4.2.281**) on the Site.

NOTE The Point (see **4.2.281**) referenced here is the same point referenced under coordinates.

#### **4.2.313.4 environmental\_references**

The environmental\_references specifies a reference to a Document (see **4.2.89**) that provides environmental information relevant to the Site.

EXAMPLE Environmental\_references specify Documents (see **4.2.89**) that describe the conditions of the environment that a Plant (see **4.2.258**) operates in that affect the design, such as snow loads, wind loads, and seismic data.

#### **4.2.313.5 locality**

The locality specifies the municipality or region where the Site is located.

#### **4.2.313.6 name**

The name specifies a textual label given to the Site.

#### **4.2.313.7 orientation**

The orientation specifies the relative alignment of the Site with respect to a given compass direction.

#### **4.2.313.8 owners**

The owners specify the company or organization that is financially responsible the Site.

#### **4.2.313.9 site\_id**

The site\_id specifies a unique identifier for the Site. Site\_id is required for each Site.

## **4.2.314. Site\_feature**

A Site\_feature is the composition, proportions, form, or outward appearance of some thing of interest on a Site (see **4.2.313**).

EXAMPLE A Site\_feature may be man-made, such as a building, road, railway, water tower or they may be natural, such as a river, hill, or forest.

The data associated with a Site\_feature are the following:

- location\_and\_orientation;
- man\_made\_or\_natural;
- shape;
- site\_feature\_id;
- type.

### **4.2.314.1 location\_and\_orientation**

The location\_and\_orientation specifies the position of the Site\_feature relative to the Site (see **4.2.313**) coordinate system and the orientation of the Site\_feature relative to a specified direction.

### **4.2.314.2 man\_made\_or\_natural**

The man\_made\_or\_natural specifies that the Site\_feature is either man-made or natural, and provides a short descriptive name or title of the feature.

### **4.2.314.3 shape**

The shape specifies a 3D spatial volume that completely encloses or bounds a feature.

NOTE The shape of the Site\_feature is necessary for the spatial layout of buildings and the piping between buildings.

### **4.2.314.4 site\_feature\_id**

The site\_feature\_id specifies a unique identifier for the Site\_feature.

### **4.2.314.5 type**

The type specifies a designation that classifies a Site\_feature based on its physical and functional characteristics.

## **4.2.315. Site\_shape\_representation**

A Site\_shape\_representation is a replica of the topography of a specific area. Each Site\_shape\_representation is either a Faceted\_surface\_representation (see **4.2.114**) or a Point\_and\_line\_representation (see **4.2.282**).

### 4.2.316. Sited\_plant

A Sited\_plant is a Planned\_physical\_plant (see 4.2.256) that a Site (see 4.2.313) location has been defined for.

The data associated with a Sited\_plant are the following:

- plant\_site\_location;
- plant\_site\_orientation.

#### 4.2.316.1 plant\_site\_location

The plant\_site\_location specifies the geographic position of the Plant (see 4.2.258) relative to the Site (see 4.2.313) or a feature of the Site.

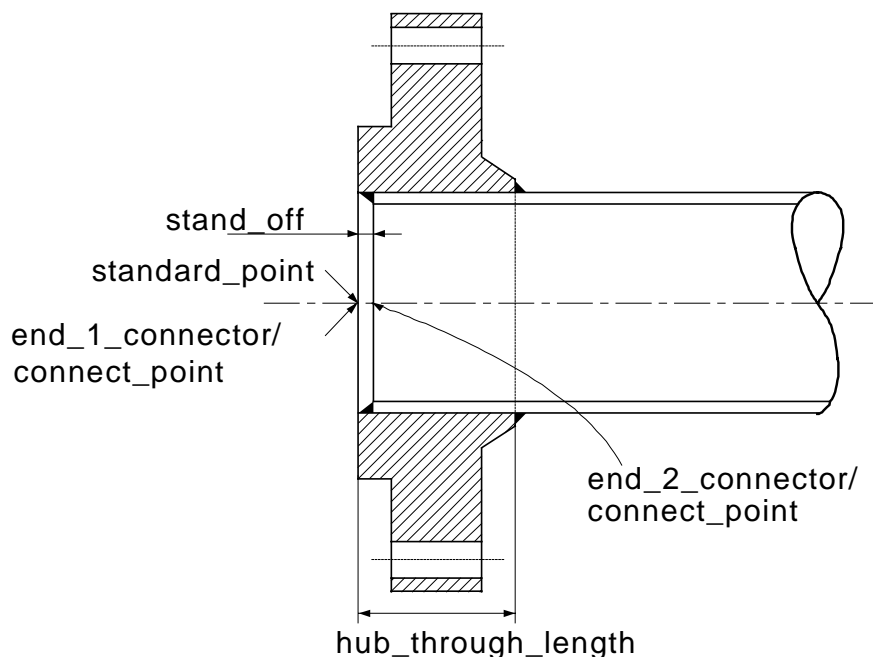
#### 4.2.316.2 plant\_site\_orientation

The plant\_site\_orientation specifies the directional orientation of the Plant (see 4.2.258) with respect to the Site (see 4.2.313).

### 4.2.317. Slip\_on\_flange

A Slip\_on\_flange is a type of Flange (see 4.2.119) that slips over the end of a Pipe (see 4.2.236) or Fitting (see 4.2.118) and is fillet welded in place.

NOTE Figure 57 depicts a typical Slip\_on\_flange.



**Figure 57 - Slip\_on\_flange**

The data associated with a Slip\_on\_flange are the following:

— stand\_off.

The stand\_off specifies the measure of the distance between the face of the Slip\_on\_flange and the end of the Pipe (see 4.2.236) or the Fitting (see 4.2.118) that is inserted into the Slip\_on\_flange. It may be specified as a single value or as a range of values.

NOTE See annex L for a discussion of attributes that may be assigned a single value or a range of values.

#### 4.2.318. Slip\_on\_jacket\_flange

A Slip\_on\_jacket\_flange is a type of Slip\_on\_flange (see 4.2.317) that slips over the end of a jacketed Piping\_spool (see 4.2.246), and closes off the jacket.

NOTE Figure 58 depicts a typical Slip\_on\_jacket\_flange.

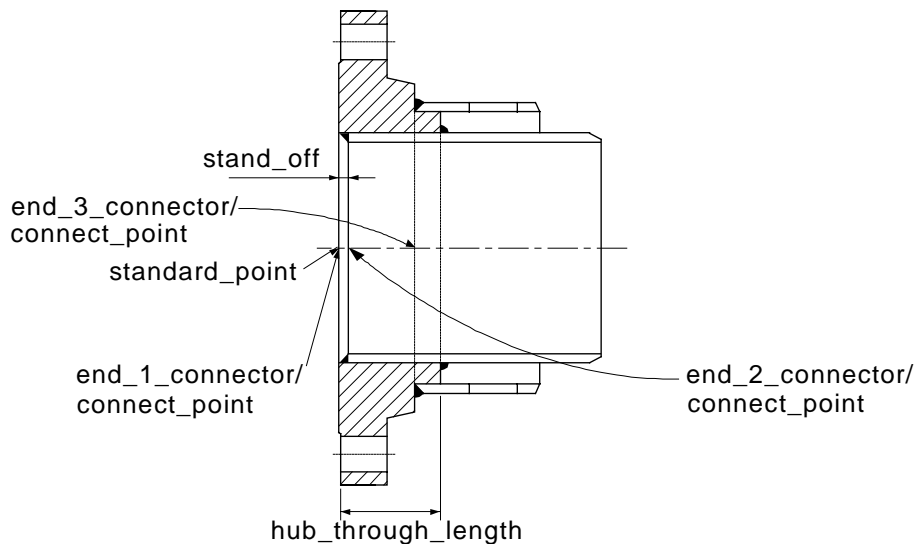


Figure 58 - Slip\_on\_jacket\_flange

The data associated with a Slip\_on\_jacket\_flange are the following:

— end\_3\_connector.

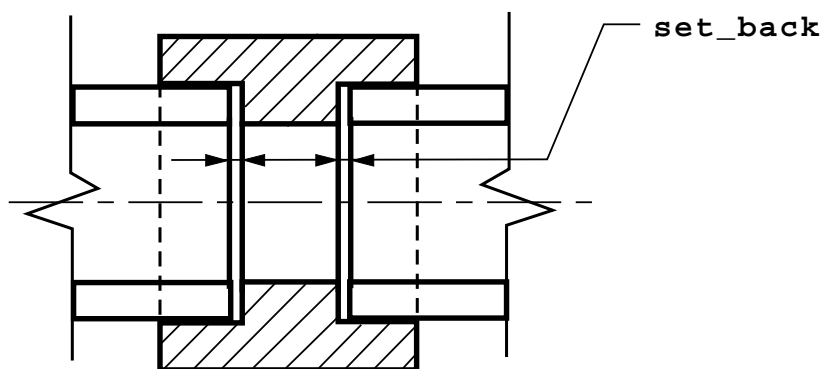
The end\_3\_connector specifies the Piping\_connector (see 4.2.242) where the outside Pipe (see 4.2.236) of the jacketed piping connects to the Flange (see 4.2.119).

#### 4.2.319. Socket

A Socket is a type of Piping\_connector (see 4.2.242) that is a physical feature of a Plant\_item (see 4.2.260) that allows partial insertion of the Male\_end (see 4.2.215) of another Plant\_item.

NOTE 1 The location of the connect point should be based on the dimension from the centreline to the bottom of the Socket of a Valve (see 4.2.367) or Fitting (see 4.2.118) plus the set\_back.

NOTE 2 Figure 59 depicts a typical Socket.



**Figure 59 - Socket**

The data associated with a Socket are the following:

— set\_back.

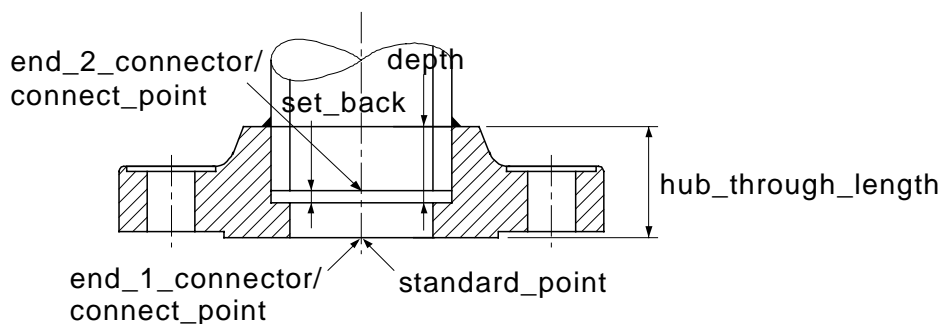
The set\_back specifies the distance between the end of the Piping\_component (see 4.2.240) and the bottom of the Socket.

NOTE The attribute for set\_back will only be used when the Piping\_component (see 4.2.240) participates in a connection.

#### 4.2.320. Socket\_weld\_flange

A Socket\_weld\_flange is a type of Flange (see 4.2.119) having a Socket (see 4.2.319) configuration that fits the end of a Pipe (see 4.2.236) for fillet welding.

NOTE Figure 60 depicts a typical Socket\_weld\_flange.



**Figure 60 - Socket\_weld\_flange**

**4.2.321. Solid\_of\_revolution**

A Solid\_of\_revolution is a type of Csg\_element (see **4.2.84**) that is formed by sweeping a 2D shape about an axis. The 2D shape may be closed or open; if open, then the ends of the 2D shape must lie on the sweep axis.

**4.2.322. Spacer**

A Spacer is a type of Fitting (see **4.2.118**) that is placed between two Flange (see **4.2.119**) objects to enable the flow of material between the pipelines on either side of the Spacer. Each Spacer may be one of the following: a Paddle\_spacer (see **4.2.231**), or a Ring\_spacer (see **4.2.301**).

The data associated with a Spacer are the following:

- outside\_diameter;
- thickness.

**4.2.322.1 outside\_diameter**

The outside\_diameter specifies the external diameter of the Spacer. It may be specified as a single value or as a range of values.

NOTE See annex L for a discussion of attributes that may be assigned a single value or a range of values.

**4.2.322.2 thickness**

The thickness specifies the distance between the two parallel faces of the Spacer. It may be specified as a single value or as a range of values.

NOTE See annex L for a discussion of attributes that may be assigned a single value or a range of values.

**4.2.323. Spare\_plant\_item\_usage**

A Spare\_plant\_item\_usage is an association between a primary Plant\_item (see **4.2.260**) and a Plant\_item used as a spare for the primary Plant\_item.

**4.2.324. Specialty\_item**

A Specialty\_item is a type of Piping\_system\_component (see **4.2.250**) whose specific dimensional design or configuration is not met by some standard commodity item.

The data associated with a Specialty\_item are the following:

- type.

The type specifies a category that the item is part of.

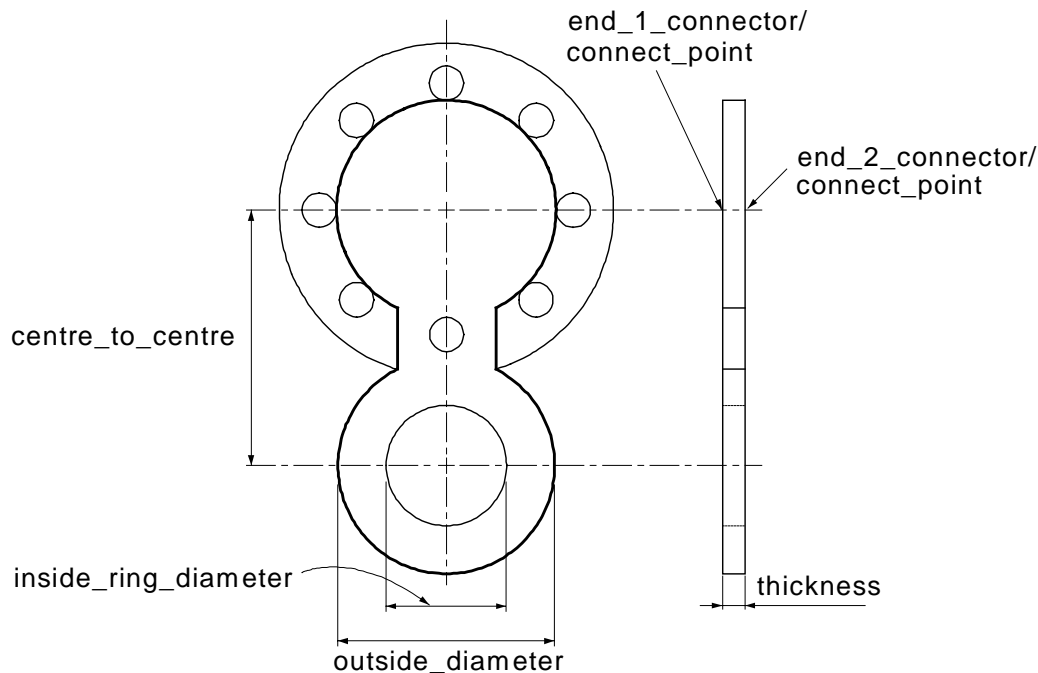
EXAMPLE Examples of Specialty\_item types include Flange (see **4.2.119**) and Valve (see **4.2.367**).

### 4.2.325. Spectacle\_blind

A Spectacle\_blind is a type of Blank (see 4.2.5) that consists of two paddles connected by an arm. One paddle blocks the flow of material (see Paddle\_blank in 4.2.230) and the other is a ring that permits or alters the flow (see Paddle\_spacer in 4.2.231). A spectacle either allows or disallows flow in a pipe depending on which end of the spectacle is installed in line. It is often used to isolate a section of the Piping\_system (see 4.2.249) or Equipment (see 4.2.104).

NOTE 1 The term spectacle refers to shape of the item, that resembles a pair of spectacles (i.e., reading glasses).

NOTE 2 Figure 61 depicts a typical Spectacle\_blind.



**Figure 61 - Spectacle\_blind**

The data associated with a Spectacle\_blind are the following:

- arm\_width;
- centre\_to\_centre;
- inside\_ring\_diameter.

#### 4.2.325.1 arm\_width

The arm\_width specifies the width of the arm connecting the paddles. It may be specified as a single value or as a range of values.

NOTE See annex L for a discussion of attributes that may be assigned a single value or a range of values.

#### 4.2.325.2 centre\_to\_centre

The `centre_to_centre` specifies the distance between the geometric centres of the paddles. It may be specified as a single value or as a range of values.

NOTE See annex L for a discussion of attributes that may be assigned a single value or a range of values.

#### **4.2.325.3 `inside_ring_diameter`**

The `inside_ring_diameter` specifies the diameter of the bore hole through the ring paddle. It may be specified as a single value or as a range of values.

NOTE See annex L for a discussion of attributes that may be assigned a single value or a range of values.

### **4.2.326. Sphere**

A Sphere is a type of `Csg_element` (see **4.2.84**) that is a solid bounded by a surface at a constant radius from a centre point.

#### **4.2.327. Splitter**

A Splitter is a vane which is placed inside an `Hvac_fitting` (see **4.2.157**) for the purpose of directing flow.

The data associated with a Splitter are the following:

- `splitter_id`;
- `splitter_radius`;
- `splitter_radius_centre_offset`;
- `straight_portion_length`.

##### **4.2.327.1 `splitter_id`**

This attribute specifies a unique identifier for the Splitter.

##### **4.2.327.2 `splitter_radius`**

This attribute specifies the radius of the Splitter.

##### **4.2.327.3 `splitter_radius_centre_offset`**

This attribute specifies the vertical distance from the throat centre to the Splitter centre.

##### **4.2.327.4 `straight_portion_length`**

This attribute specifies the length of the straight portion of the Splitter.

### **4.2.328. Spring\_washer**

A Spring\_washer is a type of Washer (see **4.2.369**). The Spring\_washer has one radial cut and both ends are pulled to opposite directions, and is furnished with the function of a coil spring.

The data associated with a Spring\_washer are the following

- thickness;
- outside\_diameter.

#### 4.2.328.1 thickness

The thickness specifies the distance between two faces of the material plate of the Spring\_washer. It may be specified as a single value or as a range of values.

NOTE See annex L for a discussion of attributes that may be assigned a single value or a range of values.

#### 4.2.328.2 outside\_diameter

The outside\_diameter specifies the external diameter of the Spring\_washer. It may be specified as a single value or as a range of values.

NOTE See annex L for a discussion of attributes that may be assigned a single value or a range of values.

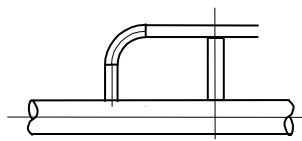
### 4.2.329. Square\_to\_round

A Square\_to\_round is a type of Csg\_element (see 4.2.84) that consists of a planar, rectangular surface, a planar circular surface parallel to the rectangular surface, and an enclosing, transitional surface that connects the boundaries of the rectangular surface and circular surface.

### 4.2.330. Stay

A Stay is a type of Reinforcing\_component (see 4.2.296) that is a tensile member placed between a run pipe and a branch pipe that are arranged in parallel. The Stay prevents the branch pipe from breaking or deforming.

NOTE Figure 62 depicts a typical Stay.



**Figure 62 - Stay**

The data associated with a Stay are the following:

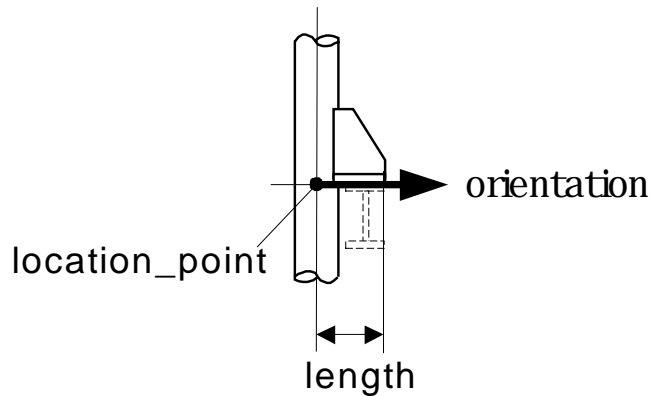
- height.

The height is the distance between the location\_point and the centreline of the branch pipe that is reinforced by the Stay.

### 4.2.331. Stopper

A Stopper is a type of Piping\_support (see 4.2.248) that consists of a plate perpendicularly fixed to the pipe axis and one or more strengthening plates for the perpendicular plate. The Stopper is used to prevent the pipe from moving.

NOTE Figure 63 depicts a typical Stopper.



**Figure 63 - Stopper**

The data associated with a Stopper are the following:

— length.

The length is the distance between the outer face of the Stopper and the location\_point.

#### **4.2.332. Straight\_pipe**

A Straight\_pipe is a type of Pipe (see 4.2.236) that does not change the direction of fluid flow.

The data associated with a Straight\_pipe are the following:

— end\_to\_end\_cut\_length;

— end\_to\_end\_length.

##### **4.2.332.1 end\_to\_end\_cut\_length**

The end\_to\_end\_cut\_length is the length of the Straight\_pipe for shop fabrication that takes into account extra length required for installation variations and the subtracted length for the difference between designed length and shop fabricated length.

EXAMPLE The root\_gap of the Buttweld (see 4.2.16) is an example of the difference between designed length and shop fabricated length.

##### **4.2.332.2 end\_to\_end\_length**

The end\_to\_end\_length specifies the external length of the Straight\_pipe. It may be specified as a single value or as a range of values.

NOTE See annex L for a discussion of attributes that may be assigned a single value or a range of values.

#### **4.2.333. Stream\_design\_case**

A `Stream_design_case` is the set of characteristics of a gas, liquid, vapour, or solid stream under a specific circumstance at the termination of a `Piping_system_line_segment` (see **4.2.252**) or a `Plant_item_connector_occurrence` (see **4.2.266**).

The data associated with a `Stream_design_case` are the following:

- `description`;
- `flow_rate`;
- `pressure`;
- `stream_case_type`;
- `stream_data_reference`;
- `stream_design_id`.

#### **4.2.333.1 description**

The `description` specifies a textual explanation or summary of the `Stream_design_case`.

#### **4.2.333.2 flow\_rate**

The `flow_rate` specifies the stream volume, mass, or molar units per unit time. It may be specified as a single value or as a range of values.

NOTE See annex L for a discussion of attributes that may be assigned a single value or a range of values.

#### **4.2.333.3 pressure**

The `pressure` specifies the amount of force applied by the stream over a unit area. It may be specified as a single value or as a range of values.

NOTE See annex L for a discussion of attributes that may be assigned a single value or a range of values.

#### **4.2.333.4 stream\_case\_type**

The `stream_case_type` specifies the condition that the stream characteristics are being defined under. `Stream_case_type` is required for each `Stream_design_case`.

EXAMPLE Examples of `stream_case_type` conditions include normal, upset, and shutdown.

#### **4.2.333.5 stream\_data\_reference**

The `stream_data_reference` specifies the sources that provide the basis for the stream data.

#### **4.2.333.6 stream\_design\_id**

The `stream_design_id` specifies a unique identifier for the `Stream_design_case`. `Stream_design_id` is required for each `Stream_design_case`.

### **4.2.334. Stream\_phase**

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A `Stream_phase` is the set of characteristics of a single gas, liquid, vapour, or solid stream that may be composed into a `Stream_design_case` (see **4.2.333**).

The data associated with a `Stream_phase` are the following:

- `constituent_mole_fraction`;
- `constituents`;
- `phase_density`;
- `phase_fraction`;
- `specific_gravity`;
- `surface_tension`;
- `temperature`;
- `viscosity`.

### **4.2.334.1 constituent\_mole\_fraction**

The `constituent_mole_fraction` specifies the mass ratio of any given component to the whole for the `Stream_phase`.

### **4.2.334.2 constituents**

The `constituents` specifies the various chemicals for the `Stream_phase`.

### **4.2.334.3 phase\_density**

The `phase_density` specifies the amount of mass per unit volume for the `Stream_phase`.

### **4.2.334.4 phase\_fraction**

The `phase_fraction` specifies the percentage of the mass of this `Stream_phase` in the `Stream_design_case` (see **4.2.333**).

### **4.2.334.5 specific\_gravity**

The `specific_gravity` specifies the ratio of the mass of a liquid to the mass of an equal volume of distilled water at 4 degrees Celsius.

### **4.2.334.6 surface\_tension**

The `surface_tension` specifies the force per unit area of the cohesive forces at or near the surface of a liquid `Stream_phase`.

### **4.2.334.7 temperature**

The temperature specifies the measure of molecular motion of a stream. It may be specified as a single value or as a range of values.

NOTE See annex L for a discussion of attributes that may be assigned a single value or a range of values.

#### **4.2.334.8 viscosity**

The viscosity specifies a measure of the resistance of a stream to deformation when subjected to a shear stress.

### **4.2.335. Structural\_component**

A Structural\_component is a type of Plant\_item (see **4.2.260**) that is an individually identifiable item or combination of items that is part of the Structural\_system (see **4.2.337**).

NOTE Structural\_component objects include structural steel members, load resisting walls, stairs, platforms foundations, supports (excluding pipe supports) for Plant\_item (see **4.2.260**) objects, and have a primary function to transfer or resist live or dead loads.

The data associated with a Structural\_component are the following:

- exact\_section;
- size\_designator;
- type.

#### **4.2.335.1 exact\_section**

The exact\_section specifies the detailed shape of a cross section of the structural element.

#### **4.2.335.2 size\_designator**

The size\_designator specifies the designation given to some types of plant structural elements to define cross-sectional size and general shape based on industry-standard practice.

EXAMPLE W30 X 132 is the U.S. American Institute of Steel Construction (AISC) designation for a wide flange beam of nominal 76.20 centimetres (30 inches) depth weighing 194.88 kilograms per metre (132 pounds per foot) of length. Similar designations exist for other plant structural elements such as angles, channels, and structural tee shapes. Also, like designations exist for other structural elements, e.g., reinforcing bar (#8 rebar).

#### **4.2.335.3 type**

The type specifies a designation that classifies a structural element based on its function in the Structural\_system (see **4.2.337**).

EXAMPLE Examples of structural element types include beam, column, brace, support, grade beam, and pile.

### **4.2.336. Structural\_load\_connector**

A Structural\_load\_connector is a type of Plant\_item\_connector (see **4.2.265**) that connects two Structural\_component (see **4.2.335**) objects for the purpose of load transfer.

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The data associated with a `Structural_load_connector` are the following:

— type.

The type specifies either a shear, moment, or shear and moment type of load at the connector.

### 4.2.337. `Structural_system`

A `Structural_system` is a type of `Plant_system` (see 4.2.276) that is an assembly of one or more `Structural_component` (see 4.2.335) objects and `Structural_load_connector` (see 4.2.336) objects.

The data associated with a `Structural_system` are the following:

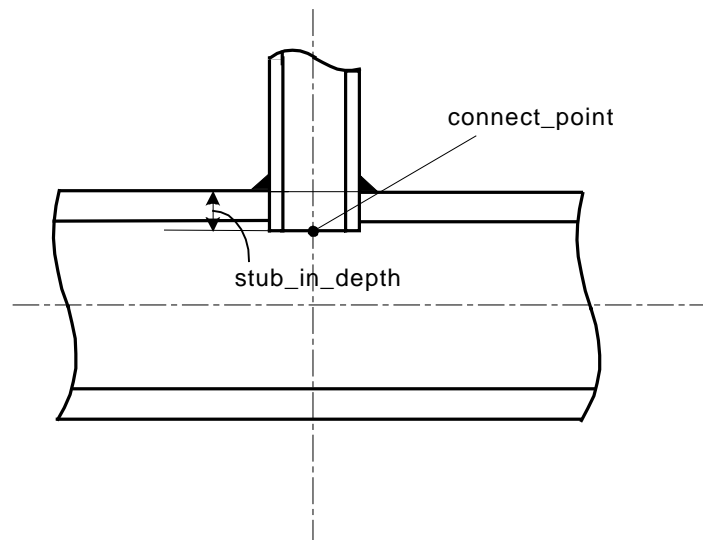
— type.

The type specifies a designation that classifies the `Structural_system` based on the kind of service that it provides.

### 4.2.338. `Stub_in`

A `Stub_in` is a type of `Piping_connector` (see 4.2.242) that consists of the welding of two `Piping_components` (see 4.2.240) where a `Male_end` (see 4.2.215) of one `Piping_component` is inserted in a `Branch_hole` (see 4.2.12) of the other `Piping_component`.

NOTE Figure 64 depicts a typical `Stub_in`.



**Figure 64 - `Stub_in`**

The data associated with a `Stub_in` are the following

— `stub_in_depth`.

The `stub_in_depth` specifies the distance from the end of the stubbed-in `Piping_component` (see 4.2.240) to the Point (see 4.2.281) where the centre line of the stubbed-in `Piping_component` intersects the outer surface of the other `Piping_component`. It may be specified as a single value or as a range of values.

NOTE 1 See annex L for a discussion of attributes that may be assigned a single value or a range of values.

NOTE 2 The attribute for `stub_in_depth` will only be used when the `Piping_component` (see 4.2.240) participates in a connection.

### 4.2.339. Stud\_bolt

A `Stud_bolt` is a type of a `Bolt` (see 4.2.8) that has screw threads on both ends.

The data associated with a `Stud_bolt` are the following

— `length`.

The `length` specifies the distance from the tip of one screw thread to the tip of the other screw thread of the `Stud_bolt`. It may be specified as a single value or as a range of values.

NOTE See annex L for a discussion of attributes that may be assigned a single value or a range of values.

### 4.2.340. Sub\_plant\_relationship

A `Sub_plant_relationship` is the relationship between `Plant` (see 4.2.258) objects and sub-plants and defines their relative locations.

EXAMPLE Examples of `Sub_plant_relationships` include manufacturing Line (see 4.2.196), Train (see 4.2.356), and `Plant` (see 4.2.258) unit.

The data associated with a `Sub_plant_relationship` are the following:

— `component`;

— `contains`;

— `location_and_orientation`.

#### 4.2.340.1 component

The `component` specifies the `plant_id` of the child `Plant` (see 4.2.258) in the `Sub_plant_relationship`.

#### 4.2.340.2 contains

The `contains` specifies the `plant_id` of the parent `Plant` (see 4.2.258) in the `Sub_plant_relationship`.

#### 4.2.340.3 location\_and\_orientation

The `location_and_orientation` specifies the relative position and orientation of the sub-plant within the `Plant` (see 4.2.258).

### 4.2.341. Supplied\_equipment

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A Supplied\_equipment is an Equipment (see **4.2.104**) that is, or is to be, provided by a Supplier (see **4.2.342**) for use in a Plant (see **4.2.258**).

The data associated with a Supplied\_equipment are the following:

- delivery\_date;
- purchase\_order\_number;
- requisition\_number.

### **4.2.341.1 delivery\_date**

The delivery\_date specifies the calendar day-month-year and time when the Equipment (see **4.2.104**) was, or is, scheduled to be delivered to the Site (see **4.2.313**).

NOTE A specific ordering of the day, month, and year within the date is not required.

### **4.2.341.2 purchase\_order\_number**

The purchase\_order\_number specifies an identifier assigned to the Equipment (see **4.2.104**) purchase order.

### **4.2.341.3 requisition\_number**

The requisition\_number specifies an identifier assigned to a written request for a piece of Equipment (see **4.2.104**).

## **4.2.342. Supplier**

A Supplier is the organization that produces a piece of Equipment (see **4.2.104**) or publishes a catalogue.

The data associated with a Supplier are the following:

- supplier\_id;
- vendor\_name.

### **4.2.342.1 supplier\_id**

The supplier\_id specifies a unique identifier for the Supplier. Supplier\_id is required for each Supplier.

### **4.2.342.2 vendor\_name**

The vendor\_name specifies a textual label used by the company or organization that is providing the Equipment (see **4.2.104**).

## **4.2.343. Support\_component**

A **Support\_component** is a type of **Plant\_item** (see **4.2.260**) that is designed to support other **Plant\_item** objects. This support includes carrying the weight of the **Plant\_item**, including internal fluids and external insulation, permitting thermal expansion and contraction, and dampening any vibrational or seismic forces applied to the **Plant\_item**. Each **Support\_component** may be a **Cable\_support** (see **4.2.18**).

EXAMPLE If a **Support\_component** is not a **Cable\_support** (see **4.2.18**), it may be a branch reinforcing pad, a hanger, a footer, pipe rack, or anything that supports the weight of a **Plant\_item** (see **4.2.260**).

#### **4.2.344. Support\_constraints**

A **Support\_constraints** is a limitation on the movement of a **Plant\_item** (see **4.2.260**) support, normally in specified directions.

The data associated with a **Support\_constraints** are the following:

- gap;
- K;
- restrained.

##### **4.2.344.1 gap**

The gap specifies the allowable space between a **Plant\_item** (see **4.2.260**) and a **Plant\_item** support.

##### **4.2.344.2 K**

The K specifies the ratio between the force applied to the support and the support deflection produced by that force.

##### **4.2.344.3 restrained**

The restrained specifies a boolean indicator that specifies whether the **Plant\_item** (see **4.2.260**) support limits movement of the **Plant\_item** in a specified direction.

#### **4.2.345. Support\_usage**

A **Support\_usage** is the relationship between a defined load bearing element and the **Plant\_item** (see **4.2.260**) that it provides support for. Each **Support\_usage** may be a **Support\_usage\_connection** (see **4.2.346**).

The data associated with a **Support\_usage** are the following:

- detail\_sheet\_reference;
- function.

##### **4.2.345.1 detail\_sheet\_reference**

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The `detail_sheet_reference` specifies the support detail drawings that define the support.

### **4.2.345.2 function**

The function specifies the role or purpose of using the `Plant_item` (see **4.2.260**) as a support.

EXAMPLE Examples of function designations include anchor, guide, restraint, and support.

### **4.2.346. Support\_usage\_connection**

A `Support_usage_connection` is a type of `Support_usage` (see **4.2.345**) that specifies the actual `Plant_item_connection_occurrence` (see **4.2.264**) where the support occurs.

### **4.2.347. Surface**

A `Surface` is a type of `Wire_and_surface_element` (see **4.2.372**) that is a set of connected points in 3D geometric space that is always locally 2D, but need not be a manifold.

NOTE `Surface` has many subtypes. Besides being a self-contained object, `Surface` is used in the definition of other geometric objects such as `Point` (see **4.2.281**) objects and `Curve` (see **4.2.85**) objects. It will not be instantiated as it has no attributes.

### **4.2.348. Survey\_point**

A `Survey_point` is a particular location (position and elevation) on a `Site` (see **4.2.313**) relative to a known geographic location.

NOTE `Survey_point` data are established by performing a survey. The collection of `Survey_point` data can be interpolated to generate a faceted or surface representation of the topography of the `Site` (see **4.2.313**).

### **4.2.349. Swept\_bend\_pipe**

A `Swept_bend_pipe` is a type of `Pipe` (see **4.2.236**) that is bent to alter the direction of flow of its contents.

The data associated with a `Swept_bend_pipe` are the following:

- `wall_thinning_allowance`;
- `centreline_radius`;
- `sweep_angle`.

#### **4.2.349.1 wall\_thinning\_allowance**

The `wall_thinning_allowance` specifies the amount of pipe wall material that must be provided to compensate for reduction in wall thickness of the `Pipe` (see **4.2.236**) caused by bending.

NOTE As a `Pipe` (see **4.2.236**) is bent, the wall thickness on the outside portion of the bend will reduce as material stretches.

#### 4.2.349.2 centreline\_radius

The `centreline_radius` specifies the radius of the `Swept_bend_pipe` circular arc as measured to the centreline of the Pipe (see 4.2.236).

#### 4.2.349.3 sweep\_angle

The `sweep_angle` specifies the subtended angle of the `Swept_bend_pipe` circular arc.

### 4.2.350. System\_space

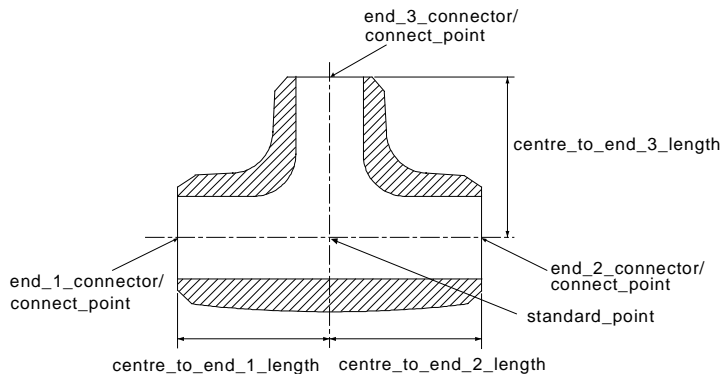
A `System_space` is a type of `Plant_volume` (see 4.2.278) that is used to describe or allocate a volume of space for use by a `Plant_system` (see 4.2.276).

EXAMPLE Examples of `System_space` type designations include electrical chases, HVAC chases, and instrumentation and control chases.

### 4.2.351. Tee

A Tee is a type of Fitting (see 4.2.118) that is a single branched outlet Fitting consisting of a straight run and a perpendicular branch used to permit straight-through and 90-degree flow.

NOTE Figure 65 depicts a typical butt-weld Tee.



**Figure 65 - Tee**

The data associated with a Tee are the following:

- `centre_to_end_1_length`;
- `centre_to_end_2_length`;
- `centre_to_end_3_length`;
- `end_1_connector`;
- `end_2_connector`;

#### **4.2.351.1 centre\_to\_end\_1\_length**

The `centre_to_end_1_length` specifies the distance from the intersection of the Tee straight-run centreline and branch-run centreline to the end-one face. It may be specified as a single value or as a range of values.

NOTE See annex L for a discussion of attributes that may be assigned a single value or a range of values.

#### **4.2.351.2 centre\_to\_end\_2\_length**

The `centre_to_end_2_length` specifies the distance from the intersection of the Tee straight-run centreline and branch-run centreline to the end-two face. It may be specified as a single value or as a range of values.

NOTE See annex L for a discussion of attributes that may be assigned a single value or a range of values.

#### **4.2.351.3 centre\_to\_end\_3\_length**

The `centre_to_end_3_length` specifies the distance from the intersection of the Tee straight-run centreline and branch-run centreline to the end-three face. It may be specified as a single value or as a range of values.

NOTE See annex L for a discussion of attributes that may be assigned a single value or a range of values.

#### **4.2.351.4 end\_1\_connector**

The `end_1_connector` specifies the `Piping_connector` (see **4.2.242**) along the straight-run centreline designated as end one.

#### **4.2.351.5 end\_2\_connector**

The `end_2_connector` specifies the `Piping_connector` (see **4.2.242**) along the straight-run centreline designated as end two.

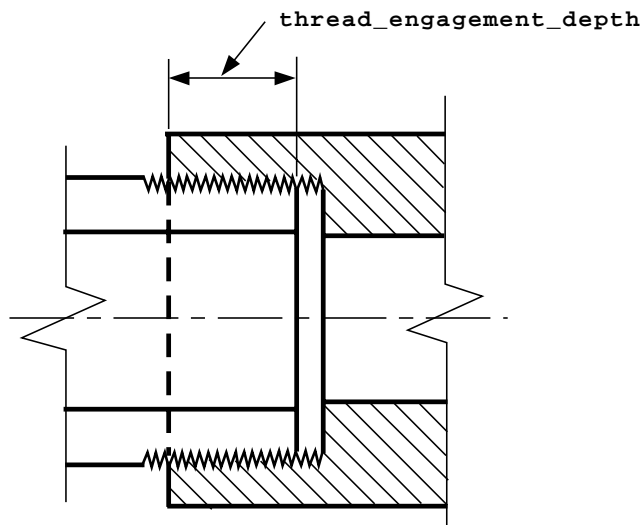
#### **4.2.351.6 end\_3\_connector**

The `end_3_connector` specifies the `Piping_connector` (see **4.2.242**) along the branch-run centreline designated as end three.

### **4.2.352. Threaded**

A **Threaded** is a type of `Piping_connector` (see **4.2.242**) that is a physical feature of a `Plant_item` (see **4.2.260**) that allows partial insertion of a male threaded connector.

NOTE Figure 66 depicts a typical Threaded end.



**Figure 66 - Threaded**

The data associated with a Threaded are the following:

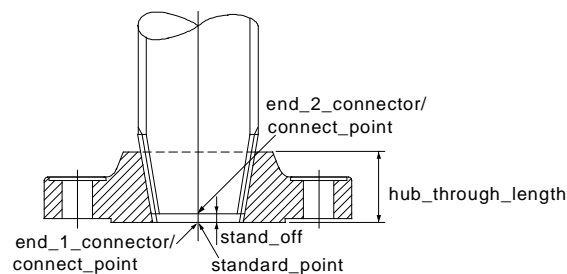
— thread\_engagement\_depth.

The thread\_engagement\_depth specifies the insertion distance of the male threaded connector into a female threaded connector.

#### 4.2.353. Threaded\_flange

A Threaded\_flange is a type of Flange (see 4.2.119) whose bore is Threaded (see 4.2.352) and that is connected to a Pipe (see 4.2.236) by screwing a threaded Pipe end into the Flange.

NOTE Figure 67 depicts a typical Threaded\_flange.



**Figure 67 - Threaded\_flange**

#### 4.2.354. Toothed\_lock\_washer

## **ISO/CD 10303-227**

A `Toothed_lock_washer` is a type of `Washer` (see **4.2.369**). The `Toothed_lock_washer` has teeth on its outer or inner, or both circular edges. The teeth are bent or twisted to improve electric conductivity when fastened.

The data associated with a `Toothed_lock_washer` are the following:

— `thickness`;

— `outside_diameter`.

### **4.2.354.1 thickness**

The `thickness` specifies the distance between two faces of the material plate of the `Toothed_lock_washer`. It may be specified as a single value or as a range of values.

NOTE See annex L for a discussion of attributes that may be assigned a single value or a range of values.

### **4.2.354.2 outside\_diameter**

The `outside_diameter` specifies the diameter of a circumscribed circle of the `Toothed_lock_washer`. It may be specified as a single value or as a range of values.

NOTE See annex L for a discussion of attributes that may be assigned a single value or a range of values.

## **4.2.355. Torus**

A `Torus` is a type of `Csg_element` (see **4.2.84**) that is defined by sweeping the area of a circle (with minor radius) about a larger circle. A `Torus` may be an `Reducing_torus` (see **4.2.294**). A `Torus` may be a `Trimmed_torus` (see **4.2.362**).

## **4.2.356. Train**

A `Train` is a type of `Plant` (see **4.2.258**) that consists of connected `Plant_items` (see **4.2.260**) that perform a distinct function. It is one of two or more distinct but similar portions of a system that perform the same function.

## **4.2.357. Trimmed\_block**

A `Trimmed_block` is a type of `Csg_element` (see **4.2.84**) that is formed by cutting a `Block` (see **4.2.7**) with one or more planes and removing one or more of the resulting sections.

## **4.2.358. Trimmed\_cone**

A `Trimmed_cone` is a type of `Csg_element` (see **4.2.84**) that is formed by cutting a `Cone` (see **4.2.68**) with one or more planes and removing one or more of the resulting sections.

## **4.2.359. Trimmed\_cylinder**

A `Trimmed_cylinder` is a type of `Csg_element` (see **4.2.84**) that is formed by cutting a `Cylinder` (see **4.2.86**) with one or more planes and removing one or more of the resulting sections.

### 4.2.360. Trimmed\_pyramid

A Trimmed\_pyramid is a type of Csg\_element (see 4.2.84) that is formed by cutting a Pyramid (see 4.2.288) with one or more planes and removing one or more of the resulting sections.

### 4.2.361. Trimmed\_sphere

A Trimmed\_sphere is a type of Csg\_element (see 4.2.84) that is formed by cutting a Sphere (see 4.2.326) with one or more planes and removing one or more of the resulting sections.

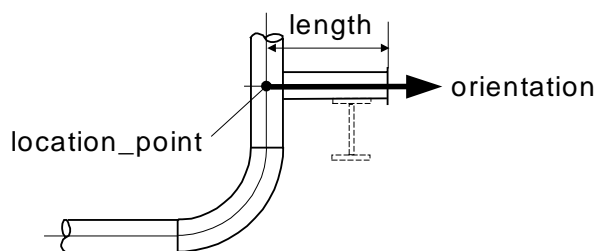
### 4.2.362. Trimmed\_torus

A Trimmed\_torus is a type of Csg\_element (see 4.2.84) that is formed by cutting a Torus (see 4.2.355) with one or more planes and removing one or more of the resulting sections.

### 4.2.363. Trunnion

A Trunnion is a type of Piping\_support (see 4.2.248) that is attached to a vertical pipe. The main body of the Trunnion is typically pipe, but shape steel or plate is occasionally used as the material of the part. The Trunnion is placed horizontally and supports the weight that acts perpendicularly to the axis of the main body.

NOTE Figure 68 depicts a typical Trunnion.



**Figure 68 - Trunnion**

The data associated with a Trunnion are the following:

— length.

The length specifies the distance between the outer face of the Trunnion and the location\_point

### 4.2.364. Union

A Union is a type of Fitting (see 4.2.118) composed of multiple pieces that allows the joining or separating of piping without rotating the piping. It consists of two internally Threaded (see 4.2.352) ends and a centre piece that draws the two ends together when rotated.

NOTE Figure 69 depicts a typical socket-weld Union.

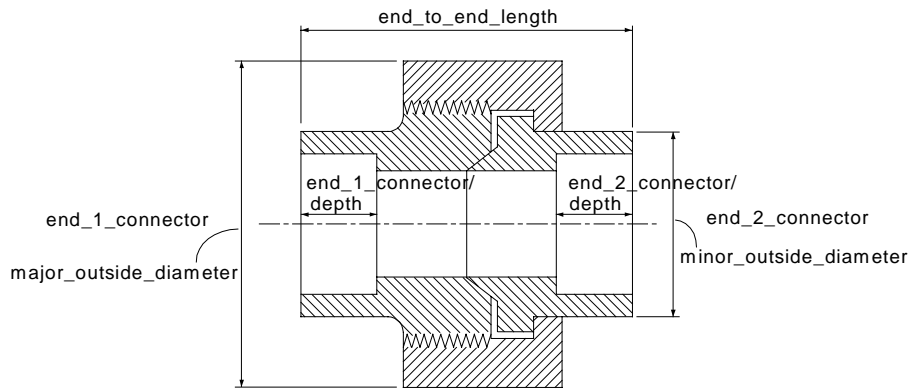


Figure 69 - Union

The data associated with a Union are the following:

- end\_1\_connector;
- end\_2\_connector;
- end\_to\_end\_length;
- major\_outside\_diameter;
- minor\_outside\_diameter.

#### 4.2.364.1 end\_1\_connector

The end\_1\_connector specifies the Piping\_connector (see 4.2.242) that corresponds to the end with the major\_outside\_diameter.

#### 4.2.364.2 end\_2\_connector

The end\_2\_connector specifies the Piping\_connector (see 4.2.242) that corresponds to the end with the minor\_outside\_diameter.

#### 4.2.364.3 end\_to\_end\_length

The end\_to\_end\_length specifies the external distance between the end-one face and the end-two face. It may be specified as a single value or as a range of values.

NOTE See annex L for a discussion of attributes that may be assigned a single value or a range of values.

#### 4.2.364.4 major\_outside\_diameter

The major\_outside\_diameter specifies the maximum diameter of the Union along the centreline, normally at the joint between the two internal pieces of the Union. It may be specified as a single value or as a range of values.

NOTE See annex L for a discussion of attributes that may be assigned a single value or a range of values.

#### 4.2.364.5 minor\_outside\_diameter

The `minor_outside_diameter` specifies the external diameter of the Union at the end-one and end-two connections. It may be specified as a single value or as a range of values.

NOTE See annex L for a discussion of attributes that may be assigned a single value or a range of values.

### **4.2.365. Unit**

A Unit is a type of Plant (see **4.2.258**) that is the designation (name or number) for a Plant or portion of a Plant that produces the same product by different means.

NOTE A Unit may perform a unique function for the Plant (see **4.2.258**) such as oxygen production, or there may be several Units that perform the same function such as multiple Units in a power generation installation. The underground or offsite portion of a Plant may be a Unit.

### **4.2.366. User\_defined\_attribute\_value**

A `User_defined_attribute_value` is a name-value pair for any characteristic that is not specified by an explicit attribute of an application object. The `User_defined_attribute_value` enables the exchange of characteristics and their values that are not defined explicitly by an application object attribute.

The data associated with a `User_defined_attribute_value` are the following:

— `name`;

— `value`.

#### **4.2.366.1 name**

The name specifies a label that characterizes the `User_defined_attribute_value`.

#### **4.2.366.2 value**

The value specifies the data for the `User_defined_attribute_value`.

### **4.2.367. Valve**

A Valve is a type of `Piping_component` (see **4.2.240**) that provides isolation or controls fluid direction or flow rate.

The data associated with a Valve are the following:

— `actuator_type`;

— `operation_mode`;

— `type`;

— `valve_stem_orientation`;

— `end_to_end_length`.

#### **4.2.367.1 actuator\_type**

The `actuator_type` specifies a descriptive designation of device or mechanism used to open, position, or close a Valve.

#### **4.2.367.2 operation\_mode**

The `operation_mode` specifies the failure mode, as in the state of being open or closed when the actuator either has no power or is in the default position.

#### **4.2.367.3 type**

The `type` specifies a designation that classifies a Valve based on its purpose that defines the design of its internals and externals.

EXAMPLE Examples of Valve type designations include gate, globe, check, and relief.

#### **4.2.367.4 valve\_stem\_orientation**

The `valve_stem_orientation` specifies the centreline direction of the Valve stem.

#### **4.2.367.5 end\_to\_end\_length**

The `end_to_end_length` specifies the distance between connecting faces of a Valve.

### **4.2.368. Vector**

A Vector is a type of Curve (see **4.2.85**). It specifies a direction in 3D space.

### **4.2.369. Washer**

A Washer is a type of Bolt\_and\_nut\_component (see **4.2.9**) that is used to improve the tightness of a screw fastener. The Washer is a flattened, ring-shaped device.

The data associated with a Washer are the following:

— `washer_type`.

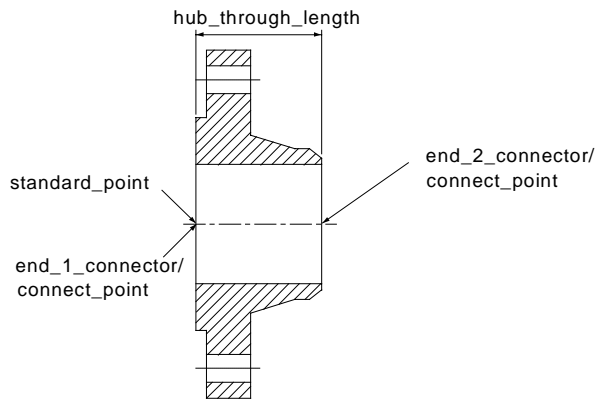
The `washer_type` specifies a classification of the Washer based on its shape characteristics.

EXAMPLE Examples of `washer_type` designations include plain, spring, and toothed\_lock.

### **4.2.370. Weld\_neck\_flange**

A `Weld_neck_flange` is a type of Flange (see **4.2.119**) with a tapered hub bored to match the inside diameter of matching Plant\_item (see **4.2.260**) and with the hub beveled for butt welding to the Plant\_item.

NOTE Figure 70 depicts a typical Weld-neck flange.

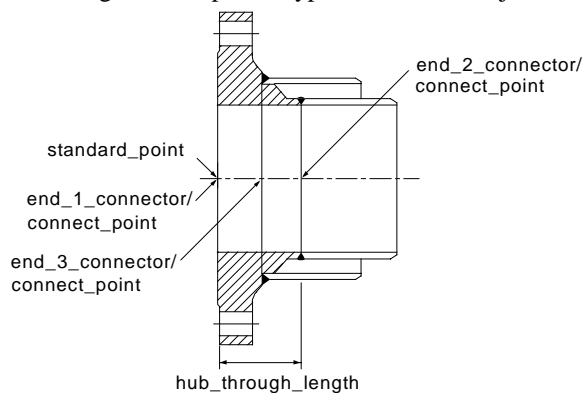


**Figure 70 - Weld\_neck\_flange**

### 4.2.371. Weld\_neck\_jacket\_flange

A **Weld\_neck\_jacket\_flange** is a type of **Weld\_neck\_flange** (see 4.2.370) that is welded onto a **Piping\_spool** (see 4.2.246) that is jacketed closing off the jacket.

NOTE Figure 71 depicts a typical **Weld\_neck\_jacket\_flange**.



**Figure 71 - Weld\_neck\_jacket\_flange**

The data associated with a **Weld\_neck\_jacket\_flange** are the following:

— **end\_3\_connector**.

The **end\_3\_connector** specifies the **Piping\_connector** (see 4.2.242) where the outside **Pipe** (see 4.2.236) of the jacketed piping connects to the **Flange** (see 4.2.119).

### 4.2.372. Wire\_and\_surface\_element

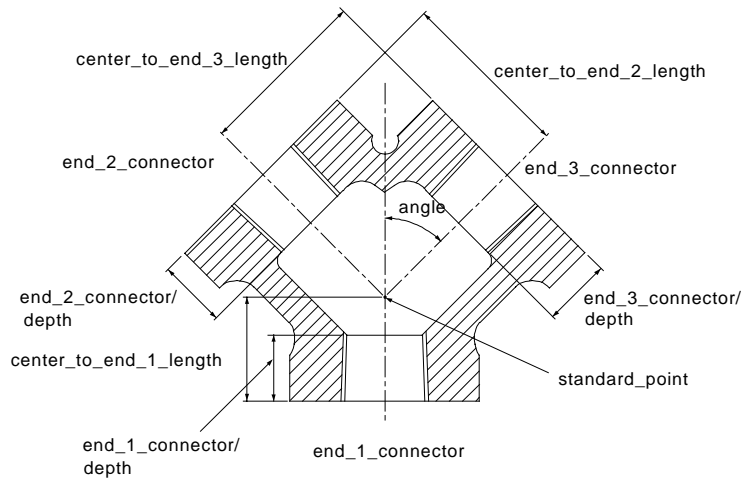
A **Wire\_and\_surface\_element** is a type of **Shape\_representation\_element** (see 4.2.310) that is composed of geometric elements. Each **Wire\_and\_surface\_element** is either: a **Curve** (see 4.2.85), a **Point** (see 4.2.281), or a **Surface** (see 4.2.347).

### 4.2.373. Y\_type\_lateral

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A `Y_type_lateral` is a type of Fitting (see **4.2.118**) that is a three-way fitting whose branches are at equal angles from the straight-run centreline forming a flow passage shaped like the letter "Y".

NOTE Figure 72 depicts a typical `Y_type_lateral`.



**Figure 72 - `Y_type_lateral`**

The data associated with a `Y_type_lateral` are the following:

- `angle`;
- `centre_to_end_1_length`;
- `centre_to_end_2_length`;
- `centre_to_end_3_length`;
- `end_1_connector`;
- `end_2_connector`;
- `end_3_connector`.

### 4.2.373.1 `angle`

The `angle` specifies the angle of the branch portions of the `Y_type_lateral` with respect to the straight run. It may be specified as a single value or as a range of values.

NOTE See annex L for a discussion of attributes that may be assigned a single value or a range of values.

### 4.2.373.2 `centre_to_end_1_length`

The `centre_to_end_1_length` specifies the distance from the intersection of the `Y_type_lateral` straight-run centreline and branch-run centreline to the end-one working Point (see **4.2.281**). It may be specified as a single value or as a range of values.

NOTE See annex L for a discussion of attributes that may be assigned a single value or a range of values.

**4.2.373.3 centre\_to\_end\_2\_length**

The `centre_to_end_2_length` specifies the distance from the intersection of the `Y_type_lateral` straight-run centreline and branch-run centreline to the end-two working Point (see **4.2.281**). It may be specified as a single value or as a range of values.

NOTE See annex L for a discussion of attributes that may be assigned a single value or a range of values.

**4.2.373.4 centre\_to\_end\_3\_length**

The `centre_to_end_3_length` specifies the distance from the intersection of the `Y_type_lateral` straight-run centreline and branch-run centreline to the end-three working Point (see **4.2.281**). It may be specified as a single value or as a range of values.

NOTE See annex L for a discussion of attributes that may be assigned a single value or a range of values.

**4.2.373.5 end\_1\_connector**

The `end_1_connector` specifies the `Piping_connector` (see **4.2.242**) designated as end one.

**4.2.373.6 end\_2\_connector**

The `end_2_connector` specifies the `Piping_connector` (see **4.2.242**) designated as end two.

**4.2.373.7 end\_3\_connector**

The `end_3_connector` specifies the `Piping_connector` (see **4.2.242**) designated as end three.

### **4.3. Application assertions**

This subclause specifies the application assertions for the plant spatial configuration application protocol. Application assertions specify the relationships among application objects, the cardinality of the relationships, and the rules required for the integrity and validity of the application objects and UoFs. The application assertions and their definitions are given below.

#### **4.3.1. Analysis\_data\_point to Plant\_item**

Each Analysis\_data\_point is defined for zero, one or many Plant\_item objects. Each Plant\_item has zero, one or many Analysis\_data\_point objects.

#### **4.3.2. Bolt\_and\_nut\_set to Bolt\_and\_nut\_component**

Each Bolt\_and\_nut\_set consists of one or more Bolt\_and\_nut\_component objects. Each Bolt\_and\_nut\_component is contained in exactly one Bolt\_and\_nut\_set.

#### **4.3.3. Breakline to Survey\_point**

Each Breakline is defined by zero, one or many Survey\_point objects. Each Survey\_point defines zero, one, or many Breakline objects.

#### **4.3.4. Building to Location\_in\_building**

Each Building is a reference frame for zero, one or many Location\_in\_building objects. Each Location\_in\_building has a reference frame provided by exactly one Building object.

#### **4.3.5. Building to Reference\_geometry**

Each Building has column lines defined by zero, one or many Reference\_geometry objects. Each Reference\_geometry defines column lines for of zero or one Building object.

#### **4.3.6. Cable to Cableway\_component**

Each Cable runs through zero, one or many Cableway\_component objects. Each Cableway\_component contains zero, one or many Cable objects.

#### **4.3.7. Cableway\_size\_description to Cableway\_component**

Each Cableway\_size\_description describes size of zero, one or many Cableway\_component objects. Each Cableway\_component has a size described by exactly one Cableway\_size\_description object.

#### **4.3.8. Catalogue\_connector to Connector\_definition**

Each Catalogue\_connector defines zero, one or many Connector\_definition objects. . Each Connector\_definition is defined by zero or one Catalogue\_connector object.

#### **4.3.9. Catalogue\_definition to Catalogue\_connector**

Each Catalogue\_definition contains zero, one or many Catalogue\_connector objects. Each Catalogue\_connector is contained by exactly one Catalogue\_definition object.

#### **4.3.10. Catalogue\_definition to Catalogue\_item**

Each Catalogue\_definition contains zero, one or many Catalogue\_item objects. Each Catalogue\_item is contained by exactly one Catalogue\_definition object.

#### **4.3.11. Catalogue\_item to Catalogue\_item\_substitute**

Each Catalogue\_item has zero, one or many Catalogue\_item\_substitute objects. Each Catalogue\_item\_substitute is exactly one Catalogue\_item object.

Each Catalogue\_item is a substitute in zero, one or many Catalogue\_item\_substitute objects. Each Catalogue\_item\_substitute identifies a substitute for exactly one Catalogue\_item object.

#### **4.3.12. Catalogue\_item to Plant\_item\_definition**

Each Catalogue\_item defines zero or one Plant\_item\_definition objects. Each Plant\_item\_definition is defined by zero or one Catalogue\_item object.

#### **4.3.13. Change to Change\_item**

Each Change changes one or more Change\_item objects. Each Change\_item is changed by zero, one, or many Change objects.

#### **4.3.14. Change to Change\_life\_cycle\_stage\_usage**

Each Change is assigned by one or more Change\_life\_cycle\_stage\_usage objects. Each Change\_life\_cycle\_stage\_usage assigns exactly one Change.

#### **4.3.15. Change\_life\_cycle\_stage to Change\_life\_cycle\_stage\_sequence**

Each Change\_life\_cycle\_stage is the predecessor in zero or one Change\_life\_cycle\_stage\_sequence objects. Each Change\_life\_cycle\_stage\_sequence has exactly one Change\_life\_cycle\_stage as the predecessor.

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Each `Change_life_cycle_stage` is the successor in zero, one or many `Change_life_cycle_stage_sequence` objects. Each `Change_life_cycle_stage_sequence` has exactly one `Change_life_cycle_stage` as the successor.

### **4.3.16. Change\_life\_cycle\_stage to Change\_life\_cycle\_stage\_usage**

Each `Change_life_cycle_stage` has changes assigned by zero or one `Change_life_cycle_stage_usage` objects. Each `Change_life_cycle_stage_usage` assigns changes for exactly one `Change_life_cycle_stage`.

### **4.3.17. Change\_life\_cycle\_stage\_usage to Change\_approval**

Each `Change_life_cycle_stage_usage` is approved by zero or one `Change_approval` objects. Each `Change_approval` approves exactly one `Change_life_cycle_stage_usage`.

### **4.3.18. Clamp\_set to Bolt\_and\_nut\_component**

Each `Clamp_set` consists of one or more `Bolt_and_nut_component` objects. Each `Bolt_and_nut_component` is associated with zero or one `Clamp_set`.

### **4.3.19. Clamp\_set to Clamp**

Each `Clamp_set` consists of one or more `Clamp` objects. Each `Clamp` is associated with exactly one `Clamp_set`.

### **4.3.20. Connected\_collection to Plant\_item\_connection**

Each `Connected_collection` contains zero, one or many `Plant_item_connection` objects. Each `Plant_item_connection` participates in zero, one or many `Connected_collection` objects.

### **4.3.21. Connection\_definition to Connector\_definition**

Each `Connection_definition` connects two or more `Connector_definition` objects. Each `Connector_definition` is connected by exactly one `Connection_definition` object.

### **4.3.22. Connection\_definition to Functional\_connection\_definition\_satisfaction**

Each `Connection_definition` is functional requirements for zero, one or many `Functional_connection_definition_satisfaction` objects. Each `Functional_connection_definition_satisfaction` gets the functional requirements from exactly one `Connection_definition` object.

Each Connection\_definition satisfies requirements for zero, one or many Functional\_connection\_definition\_satisfaction objects. Each Functional\_connection\_definition\_satisfaction has requirements satisfied by exactly one Connection\_definition object.

#### **4.3.23. Connection\_definition to Plant\_item\_connection\_occurrence**

Each Connection\_definition defines zero, one or many Plant\_item\_connection\_occurrence objects. Each Plant\_item\_connection\_occurrence is defined by zero or one Connection\_definition object.

#### **4.3.24. Connection\_material to Bolt\_and\_nut\_set**

Each Connection\_material includes zero, one or many Bolt\_and\_nut\_set objects. Each Bolt\_and\_nut\_set is used in zero, one or many Connection\_material objects.

#### **4.3.25. Connection\_material to Clamp\_set**

Each Connection\_material includes zero, one or many Clamp\_set objects. Each Clamp\_set is used in zero, one or many Connection\_material objects.

#### **4.3.26. Connector\_definition to Catalogue\_connector**

Each Connector\_definition is used as zero, one or many Catalogue\_connector objects. Each Catalogue\_connector is zero or one Connector\_definition object.

#### **4.3.27. Connector\_definition to Functional\_connector\_definition\_satisfaction**

Each Connector\_definition satisfies requirements for zero, one or many Functional\_connector\_definition\_satisfaction objects. Each Functional\_connector\_definition\_satisfaction has requirements satisfied by exactly one Connector\_definition object.

Each Connector\_definition is functional requirements for zero, one or many Functional\_connector\_definition\_satisfaction objects. Each Functional\_connector\_definition\_satisfaction gets the functional requirements from exactly one Connector\_definition object.

#### **4.3.28. Connector\_definition to Plant\_item\_connector\_occurrence**

Each Connector\_definition defines zero, one or many Plant\_item\_connector\_occurrence objects. Each Plant\_item\_connector\_occurrence is defined by zero or one Connector\_definition object.

#### **4.3.29. Design\_project to Project\_design\_assignment**

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Each Design\_project is performed in one or more Project\_design\_assignment objects. Each Project\_design\_assignment assigns a task to exactly one Design\_project object.

### **4.3.30. Document to Connection\_inspection\_record**

Each Document has inspection information defined by zero, one or many Connection\_inspection\_record objects. Each Connection\_inspection\_record defines inspection information for zero, one or many Document objects.

### **4.3.31. Document to Piping\_spool\_inspection\_record**

Each Document has inspection information defined by zero, one or many Piping\_spool\_inspection\_record objects. Each Piping\_spool\_inspection\_record defines inspection information for zero, one or many Document objects.

### **4.3.32. Ducting\_system to Stream\_design\_case**

Each Ducting\_system transports material for zero, one or many Stream\_design\_case objects. Each Stream\_design\_case defines potential material for zero, one or many Ducting\_system objects.

### **4.3.33. Equipment to Equipment\_trim\_piping**

Each Equipment requires zero, one or many Equipment\_trim\_piping objects. Each Equipment\_trim\_piping is required by exactly one Equipment object.

### **4.3.34. Equipment to Supplied\_equipment**

Each Equipment is used as zero, one or many Supplied\_equipment objects. Each Supplied\_equipment is exactly one Equipment object.

### **4.3.35. Facet\_trigon to Survey\_point**

Each Facet\_trigon is defined by exactly three Survey\_point objects. Each Survey\_point defines zero, one or many Facet\_trigon objects.

### **4.3.36. Faceted\_surface\_representation to Facet\_trigon**

Each Faceted\_surface\_representation is composed of one or more Facet\_trigon objects. Each Facet\_trigon is a component of exactly one Faceted\_surface\_representation object.

### **4.3.37. Functional\_connector to Functional\_connector\_occurrence\_satisfaction**

Each Functional\_connector is the functional requirements for zero, one, or many Functional\_connector\_occurrence\_satisfaction objects. Each Functional\_connector\_occurrence\_satisfaction gets the functional requirements from exactly one Functional\_connector object.

#### **4.3.38. Functional\_design\_view to Functional\_plant\_item\_satisfaction**

Each Functional\_design\_view is functional requirements for zero, one or many Functional\_plant\_item\_satisfaction objects. Each Functional\_plant\_item\_satisfaction gets the functional requirements from exactly one Functional\_design\_view object.

#### **4.3.39. Functional\_plant to Functional\_plant\_satisfaction**

Each Functional\_plant is functional requirements for zero, one or many Functional\_plant\_satisfaction objects. Each Functional\_plant\_satisfaction gets the functional requirements from exactly one Functional\_plant object.

#### **4.3.40. Functional\_plant to Plant\_system**

Each Functional\_plant is made up of zero, one or many Plant\_system objects. Each Plant\_system is part of exactly one Functional\_plant object.

#### **4.3.41. Functional\_design\_view to Functional\_plant\_item\_satisfaction**

Each Functional\_design\_view is the functional requirements for zero, one or many Functional\_plant\_item\_satisfaction. Each Functional\_plant\_item\_satisfaction gets the functional requirements from exactly one Functional\_design\_view.

#### **4.3.42. Hvac\_component to Hvac\_access\_opening**

Each Hvac\_component object is accessed through zero, one or many Hvac\_access\_opening objects. Each Hvac\_access\_opening object belongs to exactly one Hvac\_component object.

#### **4.3.43. Hvac\_component to Hvac\_component\_thickness**

Each Hvac\_component has skin thickness of zero, one or many Hvac\_component\_thickness objects. Each Hvac\_component\_thickness defines the skin thickness for exactly one Hvac\_component object.

#### **4.3.44. Hvac\_connector to Hvac\_connector\_service\_characteristic**

Each Hvac\_connector has zero, one or many Hvac\_connector\_service\_characteristic objects. Each Hvac\_connector\_service\_characteristic belongs to exactly one Hvac\_connector object.

#### **4.3.45. Hvac\_connector to Hvac\_cross\_section**

Each Hvac\_connector defines cross section of zero, one or many Hvac\_cross\_section objects. Each Hvac\_cross\_section is defined by exactly one Hvac\_connector object.

#### **4.3.46.       Hvac\_connector\_service\_characteristic to Service\_operating\_case**

Each Hvac\_connector\_service\_characteristic supports zero, one or many Service\_operating\_case objects. Each Service\_operating\_case is associated with exactly one Hvac\_connector\_service\_characteristic object.

#### **4.3.47.       Hvac\_elbow\_90deg\_reducing to Splitter**

Each Hvac\_elbow\_90deg\_reducing has zero, one or many Splitter objects. Each Splitter reduces the potential turbulence for exactly one Hvac\_elbow\_90deg\_reducing.

#### **4.3.48.       Hvac\_elbow\_centred to Splitter**

Each Hvac\_elbow\_centred has zero, one or many Splitter objects. Each Splitter reduces the potential turbulence for exactly one Hvac\_elbow\_centred.

#### **4.3.49.       Hvac\_elbow\_mitre to Splitter**

Each Hvac\_elbow\_mitre has zero, one or many Splitter objects. Each Splitter reduces the potential turbulence for exactly one Hvac\_elbow\_mitre.

#### **4.3.50.       Hvac\_equipment to Hvac\_flow\_control\_device**

Each Hvac\_equipment object is controlled by zero, one or many Hvac\_flow\_control\_device objects. Each Hvac\_flow\_control\_device object controls zero, one or many Hvac\_equipment objects.

#### **4.3.51.       Hvac\_instrument to Hvac\_flow\_control\_device**

Each Hvac\_instrument object provides data for zero, one or many Hvac\_flow\_control\_device objects. Each Hvac\_flow\_control\_device object is associated with zero or one Hvac\_instrument objects.

#### **4.3.52.       Hvac\_offset\_centred to Splitter**

Each Hvac\_offset\_centred has zero, one or many Splitter objects. Each Splitter reduces the potential turbulence for exactly one Hvac\_offset\_centred.

#### **4.3.53.       Hvac\_plant\_item\_branch\_connector to Hvac\_plant\_item\_branch\_connection**

Each Hvac\_plant\_item\_branch\_connector is connected to zero or one Hvac\_plant\_item\_branch\_connection. Each Hvac\_plant\_item\_branch\_connection is associated with exactly one Hvac\_plant\_item\_branch\_connector.

#### **4.3.54.      Hvac\_plant\_item\_connector to Hvac\_plant\_item\_connection**

Each Hvac\_plant\_item\_connector is connected to exactly two Hvac\_plant\_item\_connection objects. Each Hvac\_plant\_item\_connection is associated with exactly one Hvac\_plant\_item\_connector.

#### **4.3.55.      Hvac\_plant\_item\_termination to Hvac\_plant\_item\_connection**

Each Hvac\_plant\_item\_termination is connected to exactly one Hvac\_plant\_item\_connection. Each Hvac\_plant\_item\_connection is associated with exactly one Hvac\_plant\_item\_termination.

#### **4.3.56.      Hvac\_section\_branch\_termination to Hvac\_branch\_connection**

Each Hvac\_section\_branch\_termination branches from zero, one or many Hvac\_branch\_connection objects. Each Hvac\_branch\_connection is associated with exactly one Hvac\_section\_branch\_termination.

#### **4.3.57.      Hvac\_section\_segment to Hvac\_branch\_connection**

Each Hvac\_section\_segment is connected to zero, one or many Hvac\_branch\_connection objects. Each Hvac\_branch\_connection is associated with exactly one Hvac\_section\_segment.

#### **4.3.58.      Hvac\_section\_segment to Hvac\_plant\_item\_branch\_connection**

Each Hvac\_section\_segment is connected to zero, one or many Hvac\_plant\_item\_branch\_connection objects. Each Hvac\_plant\_item\_branch\_connection is associated with exactly one Hvac\_section\_segment.

#### **4.3.59.      Hvac\_section\_segment to Hvac\_section\_segment\_insulation**

Each Hvac\_section\_segment has zero, one or many Hvac\_section\_segment\_insulation objects. Each Hvac\_section\_segment\_insulation is associated with exactly one Hvac\_section\_segment.

#### **4.3.60.      Hvac\_section\_segment to Hvac\_section\_segment\_termination**

Each Hvac\_section\_segment is terminated by exactly two Hvac\_section\_segment\_termination objects. Each Hvac\_section\_segment\_termination is associated with exactly one Hvac\_section\_segment.

#### **4.3.61.      Hvac\_section\_segment to Hvac\_section\_termination**

Each Hvac\_section\_segment is started or ended by zero, one, or two Hvac\_section\_termination objects. Each Hvac\_section\_termination is associated with exactly one Hvac\_section\_segment.

#### **4.3.62.      Hvac\_section\_segment to Stream\_design\_case**

Each Hvac\_section\_segment transports material for zero, one or many Stream\_design\_case objects. Each Stream\_design\_case defines potential material for zero, one or many Hvac\_section\_segment objects.

#### **4.3.63.      Hvac\_section\_to\_section\_connection to Hvac\_section\_to\_section\_termination**

Each Hvac\_section\_to\_section\_connection connects zero, one or many Hvac\_section\_to\_section\_termination objects. Each Hvac\_section\_to\_section\_termination is associated with zero or one Hvac\_section\_to\_section\_connection objects.

#### **4.3.64.      Hvac\_specification to Hvac\_section\_segment**

Each Hvac\_specification specifies components for zero, one or many Hvac\_section\_segment objects. Each Hvac\_section\_segment has components specified by exactly one Hvac\_specification object.

#### **4.3.65.      Hvac\_system\_section to Hvac\_section\_segment**

Each Hvac\_system\_section has at least one Hvac\_section\_segment object. Each Hvac\_section\_segment is associated with exactly one Hvac\_system\_section.

#### **4.3.66.      Inspection\_condition to Connection\_inspection\_record**

Each Inspection\_condition is specified under zero, one or many Connection\_inspection\_record objects. Each Connection\_inspection\_record defines the environment for zero, one or many Inspection\_condition objects.

#### **4.3.67.      Inspection\_condition to Piping\_component\_inspection\_record**

Each Inspection\_condition is specified under zero, one or many Piping\_component\_inspection\_record objects. Each Piping\_component\_inspection\_record defines the environment for zero, one or many Inspection\_condition objects.

#### **4.3.68.      Line\_branch\_connection to Changed\_line\_branch\_connection**

Each Line\_branch\_connection is changed by zero, one, or many Changed\_line\_branch\_connection objects. Each Changed\_line\_branch\_connection changes exactly one Line\_branch\_connection.

**4.3.69. Line\_branch\_termination to Line\_branch\_connection**

Each Line\_branch\_termination is branched from exactly one Line\_branch\_connection object.  
Each Line\_branch\_connection branches to exactly one Line\_branch\_termination object.

**4.3.70. Line\_less\_piping\_system to Piping\_system\_component**

Each Line\_less\_piping\_system is composed of zero, one or many Piping\_system\_component objects. Each Piping\_system\_component is a component of zero, one or many Line\_less\_piping\_system objects.

**4.3.71. Line\_less\_piping\_system to Stream\_design\_case**

Each Line\_less\_piping\_system transports material for zero, one, or many Stream\_design\_case objects. Each Stream\_design\_case defines potential material for zero, one, or many Line\_less\_piping\_system objects.

**4.3.72. Line\_piping\_system\_component\_assignment to Changed\_line\_assignment**

Each Line\_piping\_system\_component\_assignment is changed by zero, one, or many Changed\_line\_assignment objects. Each Changed\_line\_assignment changes exactly one Line\_piping\_system\_component\_assignment.

**4.3.73. Line\_plant\_item\_branch\_connection to Changed\_line\_plant\_item\_branch\_connection**

Each Line\_plant\_item\_branch\_connection is changed by zero, one, or many Changed\_line\_plant\_item\_branch\_connection objects. Each Changed\_line\_plant\_item\_branch\_connection changes exactly one Line\_plant\_item\_branch\_connection.

**4.3.74. Line\_plant\_item\_branch\_connector to Line\_plant\_item\_branch\_connection**

Each Line\_plant\_item\_branch\_connector is connected to zero or one Line\_plant\_item\_branch\_connection object. Each Line\_plant\_item\_branch\_connection connects exactly one Line\_plant\_item\_branch\_connector object.

**4.3.75. Line\_plant\_item\_connection to Changed\_line\_plant\_item\_connection**

Each Line\_plant\_item\_connection is changed by zero, one, or many Changed\_line\_plant\_item\_connection objects. Each Changed\_line\_plant\_item\_connection changes exactly one Line\_plant\_item\_connection.

**4.3.76. Line\_plant\_item\_connector to Line\_plant\_item\_connection**

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Each Line\_plant\_item\_connector is connected to zero or one Line\_plant\_item\_connection object.  
Each Line\_plant\_item\_connection connects exactly one Line\_plant\_item\_connector object.

### **4.3.77. Line\_plant\_item\_termination to Line\_plant\_item\_connection**

Each Line\_plant\_item\_termination is connected to exactly one Line\_plant\_item\_connection object. Each Line\_plant\_item\_connection connects exactly one Line\_plant\_item\_termination object.

### **4.3.78. Line\_to\_line\_connection to Changed\_line\_to\_line\_connection**

Each Line\_to\_line\_connection is changed by zero, one or many Changed\_line\_to\_line\_connection objects. Each Changed\_line\_to\_line\_connection changes exactly one Line\_to\_line\_connection object.

### **4.3.79. Line\_to\_line\_connection to Line\_to\_line\_termination**

Each Line\_to\_line\_connection connects two or more Line\_to\_line\_termination objects. Each Line\_to\_line\_termination is connected by exactly one Line\_to\_line\_connection object.

### **4.3.80. Material\_specification\_selection to Material\_specification\_subset\_reference**

Each Material\_specification\_selection is used by zero, one or many Material\_specification\_subset\_reference objects. Each Material\_specification\_subset\_reference uses exactly one Material\_specification\_selection object.

### **4.3.81. Node to Piping\_system**

Each Node contains zero, one or many Piping\_system objects. Each Piping\_system defines branch point for zero, one or many Node objects.

### **4.3.82. Physical\_connector to Functional\_connector\_occurrence\_satisfaction**

Each Physical\_connector satisfies requirements for zero, one or many Functional\_connector\_occurrence\_satisfaction objects. Each Functional\_connector\_occurrence\_satisfaction has requirements satisfied by exactly one Physical\_connector object.

### **4.3.83. Physical\_design\_view to Functional\_plant\_item\_satisfaction**

Each Physical\_design\_view satisfies requirements for zero, one or many Functional\_plant\_item\_satisfaction objects. Each Functional\_plant\_item\_satisfaction has requirements satisfied by exactly one Physical\_design\_view object.

**4.3.84. Physical\_design\_view to Installed\_physical\_design\_view**

Each Physical\_design\_view is used as zero or one Installed\_physical\_design\_view object. Each Installed\_physical\_design\_view is exactly one Physical\_design\_view object.

**4.3.85. Piping\_assembly to Piping\_assembly\_assignment**

Each Piping\_assembly is in zero, one or many Piping\_assembly\_assignment objects. Each piping\_assembly\_assignment assembles exactly one Piping\_assembly.

**4.3.86. Piping\_component to Family\_definition**

Each Piping\_component defines zero or one Family\_definition object. Each Family\_definition is defined by zero or one Piping\_component object.

**4.3.87. Piping\_component to Piping\_component\_inspection\_record**

Each Piping\_component has zero, one or many Piping\_component\_inspection\_record objects. Each Piping\_component\_inspection\_record belongs to exactly one Piping\_component object.

**4.3.88. Piping\_component\_inspection\_record to Document**

Each Piping\_component\_inspection\_record has inspection information defined by zero, one or many Document objects. Each Document defines inspection information for zero, one or many Piping\_component\_inspection\_record objects.

**4.3.89. Piping\_connector to  
Piping\_connector\_service\_characteristic**

Each Piping\_connector provides zero or one Piping\_connector\_service\_characteristic object. Each Piping\_connector\_service\_characteristic is provided by exactly one Piping\_connector object.

**4.3.90. Piping\_connector to Piping\_size\_description**

Each Piping\_connector has a size described by zero, one or many Piping\_size\_description objects. Each Piping\_size\_description describes the size of zero, one or many Piping\_connector objects.

**4.3.91. Piping\_connector\_service\_characteristic to  
Service\_operating\_case**

Each Piping\_connector\_service\_characteristic supports zero, one or many Service\_operating\_case objects. Each Service\_operating\_case is supported by exactly one Piping\_connector\_service\_characteristic object.

**4.3.92. Piping\_specification to Changed\_piping\_specification**

Each Piping\_specification is changed by zero, one, or many Changed\_piping\_specification objects. Each Changed\_piping\_specification changes exactly one Piping\_specification.

#### **4.3.93. Piping\_specification to Family\_definition**

Each Piping\_specification is composed of one or more Family\_definition objects. Each Family\_definition is part of exactly one Piping\_specification object.

#### **4.3.94. Piping\_specification to Piping\_system\_line\_segment**

Each Piping\_specification specifies components for zero, one or many Piping\_system\_line\_segment objects. Each Piping\_system\_line\_segment has components specified by exactly one Piping\_specification object.

#### **4.3.95. Piping\_spool to Piping\_spool\_inspection\_record**

Each Piping\_spool has zero, one or many Piping\_spool\_inspection\_record objects. Each Piping\_spool\_inspection\_record is part of exactly one Piping\_spool object.

#### **4.3.96. Piping\_spool to Shape\_inspection\_record**

Each Piping\_spool has zero, one or many Shape\_inspection\_record objects. Each Shape\_inspection\_record is part of zero or one Piping\_spool object.

#### **4.3.97. Piping\_spool\_inspection\_record to Inspection\_condition**

Each Piping\_spool\_inspection\_record is specified under zero, one or many Inspection\_condition objects. Each Inspection\_condition defines the environment for zero, one or many Piping\_spool\_inspection\_record objects.

#### **4.3.98. Piping\_system to Piping\_system\_line**

Each Piping\_system is made up of zero, one or many Piping\_system\_line objects. Each Piping\_system\_line is part of exactly one Piping\_system object.

#### **4.3.99. Piping\_system\_component to Equipment\_trim\_piping**

Each Piping\_system\_component is used as zero, one or many Equipment\_trim\_piping objects. Each Equipment\_trim\_piping is exactly one Piping\_system\_component object.

#### **4.3.100. Piping\_system\_component to Line\_piping\_system\_component\_assignment**

Each Piping\_system\_component satisfies zero, one or many Line\_piping\_system\_component\_assignment objects. Each Line\_piping\_system\_component\_assignment is satisfied by exactly one Piping\_system\_component object.

**4.3.101. Piping\_system\_component to Piping\_size\_description**

Each Piping\_system\_component has a size described by zero, one or many Piping\_size\_description objects. Each Piping\_size\_description describes the size of zero, one or many Piping\_system\_component objects.

**4.3.102. Piping\_system\_line to Changed\_piping\_system\_line**

Each Piping\_system\_line is changed by zero, one, or many Changed\_piping\_system\_line objects. Each Changed\_piping\_system\_line changes exactly one Piping\_system\_line.

**4.3.103. Piping\_system\_line to Piping\_system\_line\_segment**

Each Piping\_system\_line is composed of one or more Piping\_system\_line\_segment objects. Each Piping\_system\_line\_segment is a component of exactly one Piping\_system\_line object.

**4.3.104. Piping\_system\_line to Piping\_system\_line\_termination**

Each Piping\_system\_line is start or ended by zero, one or two Piping\_system\_line\_termination objects. Each Piping\_system\_line\_termination starts or ends exactly one Piping\_system\_line object.

**4.3.105. Piping\_system\_line\_segment to  
Changed\_piping\_system\_line\_segment**

Each Piping\_system\_line\_segment is changed by zero, one, or many Changed\_piping\_system\_line\_segment objects. Each Changed\_piping\_system\_line\_segment changes exactly one Piping\_system\_line\_segment.

**4.3.106. Piping\_system\_line\_segment to Line\_branch\_connection**

Each Piping\_system\_line\_segment has branches defined by zero, one or many Line\_branch\_connection objects. Each Line\_branch\_connection defines the branches of exactly one Piping\_system\_line\_segment object.

**4.3.107. Piping\_system\_line\_segment to  
Line\_plant\_item\_branch\_connection**

Each Piping\_system\_line\_segment is connected to zero, one, or many Line\_plant\_item\_branch\_connection objects. Each Line\_plant\_item\_branch\_connection defines the branches of exactly one Piping\_system\_line\_segment.

**4.3.108. Piping\_system\_line\_segment to  
Line\_piping\_system\_component\_assignment**

Each Piping\_system\_line\_segment defines the need for zero, one or many Line\_piping\_system\_component\_assignment objects. Each Line\_piping\_system\_component\_assignment satisfies the need defined by exactly one Piping\_system\_line\_segment object.

#### **4.3.109.      Piping\_system\_line\_segment to Piping\_system\_line\_segment\_termination**

Each Piping\_system\_line\_segment is terminated by exactly two Piping\_system\_line\_segment\_termination objects; one is termination\_1 and the other is termination\_2. Each Piping\_system\_line\_segment\_termination terminates exactly one Piping\_system\_line\_segment object.

#### **4.3.110.      Piping\_system\_line\_segment to Segment\_insulation**

Each Piping\_system\_line\_segment requires zero, one or many Segment\_insulation objects. Each Segment\_insulation is required by exactly one Piping\_system\_line\_segment object.

#### **4.3.111.      Piping\_system\_line\_segment to Stream\_design\_case**

Each Piping\_system\_line\_segment defines transport needs for zero, one, or many Stream\_design\_case objects. Each Stream\_design\_case defines potential material for zero, one, or many Piping\_system\_line\_segment objects.

#### **4.3.112.      Piping\_system\_line\_segment\_termination to Changed\_piping\_system\_line\_segment\_termination**

Each Piping\_system\_line\_segment\_termination is changed by zero, one, or many Changed\_piping\_system\_line\_segment\_termination objects. Each Changed\_piping\_system\_line\_segment\_termination changes exactly one Piping\_system\_line\_segment\_termination.

#### **4.3.113.      Planned\_physical\_plant to Changed\_planned\_physical\_plant**

Each Planned\_physical\_plant is changed by zero, one, or many Changed\_planned\_physical\_plant objects. Each Changed\_planned\_physical\_plant changes exactly one Planned\_physical\_plant.

#### **4.3.114.      Planned\_physical\_plant to Functional\_plant\_satisfaction**

Each Planned\_physical\_plant satisfies requirements for zero, one or many Functional\_plant\_satisfaction objects. Each Functional\_plant\_satisfaction has requirements satisfied by exactly one Planned\_physical\_plant object.

#### **4.3.115.      Planned\_physical\_plant to Location\_in\_plant**

Each Planned\_physical\_plant contains zero, one or many Location\_in\_plant objects. Each Location\_in\_plant is located in zero, one or many Planned\_physical\_plant objects.

#### **4.3.116.      Planned\_physical\_plant to Sited\_plant**

Each Planned\_physical\_plant is used as zero or one Sited\_plant object. Each Sited\_plant is exactly one Planned\_physical\_plant object.

#### **4.3.117.      Planned\_physical\_plant\_item to Piping\_assembly\_assignment**

Each Planned\_physical\_plant\_item is assigned by zero or one Piping\_assembly\_assignment object. Each Piping\_assembly\_assignment assigns exactly one Planned\_physical\_plant\_item object.

#### **4.3.118.      Planned\_physical\_plant\_item to Plant\_item\_connector\_occurrence**

Each Planned\_physical\_plant\_item has zero, one or many Plant\_item\_connector\_occurrence objects. Each Plant\_item\_connector\_occurrence is part of exactly one Planned\_physical\_plant\_item object.

#### **4.3.119.      Planned\_physical\_plant\_item to Support\_usage**

Each Planned\_physical\_plant\_item is supported by zero, one or many Support\_usage objects. Each Support\_usage identifies exactly one Planned\_physical\_plant\_item object that supports another.

Each Planned\_physical\_plant\_item supports zero, one or many Support\_usage objects. Each Support\_usage identifies exactly one Planned\_physical\_plant\_item object that is supported.

#### **4.3.120.      Plant to Changed\_plant**

Each Plant is changed by zero, one, or many Changed\_plant objects. Each Changed\_plant changes exactly one Plant.

#### **4.3.121.      Plant to External\_classification**

Each Plant is classified by zero, one or many External\_classification objects. Each External\_classification classifies zero, one or many Plant objects.

#### **4.3.122.      Plant to Functional\_plant**

Each Plant is used as zero or one Functional\_plant object. Each Functional\_plant is exactly one Plant object.

#### **4.3.123.      Plant to Planned\_physical\_plant**

Each Plant is realized as zero, one or many Planned\_physical\_plant objects. Each Planned\_physical\_plant is the realization of exactly one Plant object.

#### **4.3.124.      Plant to Plant\_process\_capability**

Each Plant produces zero, one or many Plant\_process\_capability objects. Each Plant\_process\_capability is produced by exactly one Plant object.

#### **4.3.125. Plant to Sub\_plant\_relationship**

Each Plant contains zero, one or many Sub\_plant\_relationship objects. Each Sub\_plant\_relationship is contained in exactly one Plant object.

Each Plant is used in zero, one or many Sub\_plant\_relationship objects. Each Sub-plant\_relationship uses exactly one Plant object.

#### **4.3.126. Plant\_item to Changed\_plant\_item**

Each Plant\_item is changed by zero, one, or many Changed\_plant\_item objects. Each Changed\_plant\_item changes exactly one Plant\_item.

#### **4.3.127. Plant\_item to Document**

Each Plant\_item has reference of zero, one or many Document objects. Each Document is reference for zero, one or many Plant\_item objects.

#### **4.3.128. Plant\_item to External\_classification**

Each Plant\_item is classified by zero, one or many External\_classification objects. Each External\_classification classifies zero, one or many Plant\_item objects.

#### **4.3.129. Plant\_item to Insulation**

Each Plant\_item is insulated by zero, one or many Insulation objects. Each Insulation insulates zero or one Plant\_item object.

#### **4.3.130. Plant\_item to Plant\_item\_collection**

Each Plant\_item is a group of zero, one, or many Plant\_item\_collection objects. Each Plant\_item\_collection identifies as a group exactly one Plant\_item object.

Each Plant\_item is an element in zero, one or many Plant\_item\_collection objects. Each Plant\_item\_collection identifies as an element of a collection exactly one Plant\_item object.

#### **4.3.131. Plant\_item to Plant\_item\_design\_view**

Each Plant\_item is defined as one or more Plant\_item\_design\_view objects. Each Plant\_item\_design\_view defines exactly one Plant\_item object.

#### **4.3.132. Plant\_item to Plant\_item\_shape**

Each Plant\_item is spatially described by zero or one Plant\_item\_shape object. Each Plant\_item\_shape spatially describes exactly one Plant\_item object.

**4.3.133. Plant\_item to Plant\_item\_weight**

Each Plant\_item is measured as having zero, one or many Plant\_item\_weight objects. Each Plant\_item\_weight is the measured weight of exactly one Plant\_item object.

**4.3.134. Plant\_item to Reference\_geometry**

Each Plant\_item references zero, one or many Reference\_geometry objects. Each Reference\_geometry is referenced by zero, one or many Plant\_item objects.

**4.3.135. Plant\_item to Required\_material\_description**

Each Plant\_item satisfies zero, one or many Required\_material\_description objects. Each Required\_material\_description is satisfied by zero, one or many Plant\_item objects.

**4.3.136. Plant\_item to Spare\_plant\_item\_usage**

Each Plant\_item is the primary plant item in zero, one or many Spare\_plant\_item\_usage objects. Each Spare\_plant\_item\_usage has as a primary plant item exactly one Plant\_item object.

Each Plant\_item is the spare plant item in zero, one or many Spare\_plant\_item\_usage objects. Each Spare\_plant\_item\_usage has as a spare plant item exactly one Plant\_item object.

**4.3.137. Plant\_item to User\_defined\_attribute\_value**

Each Plant\_item is characterized by zero, one or many User\_defined\_attribute\_value objects. Each User\_defined\_attribute\_value characterizes exactly one Plant\_item object.

**4.3.138. Plant\_item\_collection to Changed\_plant\_item\_collection**

Each Plant\_item\_collection is changed by zero, one, or many Changed\_plant\_item\_collection objects. Each Changed\_plant\_item\_collection changes exactly one Plant\_item\_collection.

**4.3.139. Plant\_item\_connection to Changed\_plant\_item\_connection**

Each Plant\_item\_connection is changed by zero, one, or many Changed\_plant\_item\_connection objects. Each Changed\_plant\_item\_connection changes exactly one Plant\_item\_connection.

**4.3.140. Plant\_item\_connection to Connection\_inspection\_record**

Each Plant\_item\_connection has zero, one or many Connection\_inspection\_record objects. Each Connection\_inspection\_record is part of exactly one Plant\_item\_connection object.

**4.3.141. Plant\_item\_connection to Connection\_material**

Each Plant\_item\_connection uses one or more Connection\_material objects. Each Connection\_material is used by exactly one Plant\_item\_connection object.

#### **4.3.142. Plant\_item\_connection\_occurrence to Functional\_connection\_occurrence\_satisfaction**

Each Plant\_item\_connection\_occurrence is the functional requirements for zero, one or many Functional\_connection\_occurrence\_satisfaction objects. Each Functional\_connection\_occurrence\_satisfaction gets the functional requirements from exactly one Plant\_item\_connection\_occurrence object.

Each Plant\_item\_connection\_occurrence satisfies the requirements for zero, one or many Functional\_connection\_occurrence\_satisfaction objects. Each Functional\_connection\_occurrence\_satisfaction has requirements satisfied by exactly one Plant\_item\_connection\_occurrence object.

#### **4.3.143. Plant\_item\_connection\_occurrence to Plant\_item\_connector\_occurrence**

Each Plant\_item\_connection\_occurrence connects two or more Plant\_item\_connector\_occurrence objects. Each Plant\_item\_connector\_occurrence is connected by zero or one Plant\_item\_connection\_occurrence object.

#### **4.3.144. Plant\_item\_connector to Changed\_plant\_item\_connector**

Each Plant\_item\_connector is changed by zero, one, or many Changed\_plant\_item\_connector objects. Each Changed\_plant\_item\_connector changes exactly one Plant\_item\_connector.

#### **4.3.145. Plant\_item\_connector to Document**

Each Plant\_item\_connector has reference of zero, one or many Document objects. Each Document is reference for zero, one or many Plant\_item\_connector objects.

#### **4.3.146. Plant\_item\_connector to External\_classification**

Each Plant\_item\_connector is classified by zero, one or many External\_classification objects. Each External\_classification classifies zero, one or many Plant\_item\_connector objects.

#### **4.3.147. Plant\_item\_connector to Piping\_component\_inspection\_record**

Each Plant\_item\_connector has zero, one or many Piping\_component\_inspection\_record objects. Each Piping\_component\_inspection\_record is part of exactly one Plant\_item\_connector object.

#### **4.3.148. Plant\_item\_connector to Required\_material\_description**

Each Plant\_item\_connector has material requirements defined by zero, one or many Required\_material\_description objects. Each Required\_material\_description defines material requirements for zero, one or many Plant\_item\_connector objects.

**4.3.149. Plant\_item\_connector to Shape\_representation**

Each Plant\_item\_connector has shape defined by zero, one or many Shape\_representation objects. Each Shape\_representation defines the shape of zero, one or many Plant\_item\_connector objects.

**4.3.150. Plant\_item\_definition to Catalogue\_item**

Each Plant\_item\_definition is used as zero, one or many Catalogue\_item objects. Each Catalogue\_item is zero or one Plant\_item\_definition object.

**4.3.151. Plant\_item\_definition to Connector\_definition**

Each Plant\_item\_definition has one or more Connector\_definition objects. Each Connector\_definition is part of zero or one Plant\_item\_definition object.

**4.3.152. Plant\_item\_definition to Planned\_physical\_plant\_item**

Each Plant\_item\_definition defines zero, one or many Planned\_physical\_plant\_item objects. Each Planned\_physical\_plant\_item is defined by zero or one Plant\_item\_definition object.

**4.3.153. Plant\_item\_instance to Plant\_item\_interference**

Each Plant\_item\_instance is the first item in zero, one or many Plant\_item\_interference objects. Each Plant\_item\_interference has as its first item exactly one Plant\_item\_instance object.

Each Plant\_item\_instance is the second item in zero, one or many Plant\_item\_interference objects. Each Plant\_item\_interference has as its second item exactly one Plant\_item\_instance object.

**4.3.154. Plant\_item\_instance to Plant\_item\_location**

Each Plant\_item\_instance is located by zero or one Plant\_item\_location object. Each Plant\_item\_location locates exactly one Plant\_item\_instance object. A Plant\_item\_instance shall be located only once in either a plant, site, or building or multiple times with respect to other Plant\_item objects. A Plant\_item\_instance shall not be located more than once in a plant, site, or building.

**4.3.155. Plant\_item\_instance to Project\_design\_assignment**

Each Plant\_item\_instance is assigned by zero, one or many Project\_design\_assignment objects. Each Project\_design\_assignment assigns exactly one Plant\_item\_instance object.

**4.3.156. Plant\_item\_instance to Relative\_item\_location**

Each Plant\_item\_instance is the referenced item for zero, one or many Relative\_item\_location objects. Each Relative\_item\_location references exactly one Plant\_item\_instance object.

#### **4.3.157. Plant\_item\_interference to Interfering\_shape\_element**

Each Plant\_item\_interference has intersecting geometry of zero, one or many Interfering\_shape\_element objects. Each Interfering\_shape\_element is the intersecting geometry for exactly one Plant\_item\_interference object.

#### **4.3.158. Plant\_item\_interference to Plant\_item\_interference\_status**

Each Plant\_item\_interference has a status of one or more Plant\_item\_interference\_status objects. Each Plant\_item\_interference\_status provides the status for exactly one Plant\_item\_interference object.

#### **4.3.159. Plant\_item\_interference to Shape\_interference\_zone\_usage**

Each Plant\_item\_interference has a zone of interference defined by zero, one or many Shape\_interference\_zone\_usage objects. Each Shape\_interference\_zone\_usage defines the zone of interference for exactly one Plant\_item\_interference object.

#### **4.3.160. Plant\_item\_location to Changed\_plant\_item\_location**

Each Plant\_item\_location is changed by zero, one, or many Changed\_plant\_item\_location objects. Each Changed\_plant\_item\_location changes exactly one Plant\_item\_location.

#### **4.3.161. Plant\_item\_shape to Changed\_plant\_item\_shape**

Each Plant\_item\_shape is changed by zero, one, or many Changed\_plant\_item\_shape objects. Each Changed\_plant\_item\_shape changes exactly one Plant\_item\_shape.

#### **4.3.162. Plant\_item\_shape to Shape\_representation**

Each Plant\_item\_shape is defined using zero, one or many Shape\_representation objects. Each Shape\_representation defines exactly one Plant\_item\_shape object.

#### **4.3.163. Plant\_process\_capability to Changed\_plant\_process\_capability**

Each Plant\_process\_capability is changed by zero, one, or many Changed\_plant\_process\_capability objects. Each Changed\_plant\_process\_capability changes exactly one Plant\_process\_capability.

#### **4.3.164. Plant\_system to Changed\_plant\_system**

Each Plant\_system is changed by zero, one, or many Changed\_plant\_system objects. Each Changed\_plant\_system changes exactly one Plant\_system.

#### **4.3.165. Plant\_system to External\_classification**

Each Plant\_system is classified by zero, one or many External\_classification objects. Each External\_classification classifies zero, one or many Plant\_system objects.

#### **4.3.166. Plant\_system to Plant\_item**

Each Plant\_system is composed of zero, one or many Plant\_item objects. Each Plant\_item is part of zero, one or many Plant\_system objects.

#### **4.3.167. Plant\_system to Plant\_system\_assembly**

Each Plant\_system is the super-system in zero, one or many Plant\_system\_assembly objects. Each Plant\_system\_assembly has exactly one Plant\_system object as the super-system.

Each Plant\_system is the sub-system in zero, one or many Plant\_system\_assembly objects. Each Plant\_system\_assembly has exactly one Plant\_system object as the sub-system.

#### **4.3.168. Point\_and\_line\_representation to Survey\_point**

Each Point\_and\_line\_representation is defined by zero, one or many Survey\_point objects. Each Survey\_point defines zero, one or many Point\_and\_line\_representation objects.

#### **4.3.169. Raceway to Raceway\_lane**

Each Raceway contains zero, one or many Raceway\_lane objects. Each Raceway\_lane is contained in exactly one Raceway object.

#### **4.3.170. Reference\_geometry to Changed\_reference\_geometry**

Each Reference\_geometry is changed by zero, one, or many Changed\_reference\_geometry objects. Each Changed\_reference\_geometry changes exactly one Reference\_geometry.

#### **4.3.171. Reference\_geometry to Shape\_representation\_element**

Each Reference\_geometry is described by zero, one or many Shape\_representation\_element objects. Each Shape\_representation\_element provides description of zero, one or many Reference\_geometry objects.

#### **4.3.172. Required\_material\_description to Changed\_required\_material\_description**

Each Required\_material\_description is changed by zero, one, or many Changed\_required\_material\_description objects. Each Changed\_required\_material\_description changes exactly one Required\_material\_description.

#### **4.3.173. Required\_material\_description to Material\_specification\_selection**

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Each Required\_material\_description is satisfied by zero, one or many Material\_specification\_selection objects. Each Material\_specification\_selection satisfies zero, one or many Required\_material\_description objects.

### **4.3.174. Route to Node**

Each Route consists of one or more Node objects. Each Node is associated with exactly one Route.

### **4.3.175. Route to Piping\_system\_line\_segment**

Each Route is composed of zero, one or many Piping\_system\_line\_segment objects. Each Piping\_system\_line\_segment is a component of zero or one Route object.

### **4.3.176. Shape\_inspection\_record to Plant\_item\_connector**

Each Shape\_inspection\_record has inspected shape defined by zero, one or many Plant\_item\_connector objects. Each Plant\_item\_connector defines inspected shape of zero, one or many Shape\_inspection\_record objects.

### **4.3.177. Shape\_representation to Shape\_representation\_element\_usage**

Each Shape\_representation is defined by one or more Shape\_representation\_element\_usage objects. Each Shape\_representation\_element\_usage defines exactly one Shape\_representation object.

### **4.3.178. Shape\_representation\_element to Shape\_interference\_zone\_usage**

Each Shape\_representation\_element defines a volume for zero or one Shape\_interference\_zone\_usage object. Each Shape\_interference\_zone\_usage has a volume defined by exactly one Shape\_representation\_element object.

### **4.3.179. Shape\_representation\_element to Shape\_representation\_element\_usage**

Each Shape\_representation\_element provides a definition for zero or one Shape\_representation\_element\_usage object. Each Shape\_representation\_element\_usage has a definition provided by exactly one Shape\_representation\_element object.

### **4.3.180. Shape\_representation\_element\_usage to Interfering\_shape\_element**

Each Shape\_representation\_element\_usage is the intersecting geometry of zero, one or many Interfering\_shape\_element objects. Each Interfering\_shape\_element uses as intersecting geometry exactly one Shape\_representation\_element\_usage object.

**4.3.181. Site to Building**

Each Site has located on it zero, one or many Building objects. Each Building is located on exactly one Site object.

**4.3.182. Site to Changed\_site**

Each Site is changed by zero, one, or many Changed\_site objects. Each Changed\_site changes exactly one Site.

**4.3.183. Site to Location\_in\_site**

Each Site is a reference frame for zero, one or many Location\_in\_site objects. Each Location\_in\_site has a reference frame provided by exactly one Site object.

**4.3.184. Site to Site\_feature**

Each Site contains zero, one or many Site\_feature objects. Each Site\_feature is contained in exactly one Site object.

**4.3.185. Site to Site\_shape\_representation**

Each Site has shape defined by zero, one or many Site\_shape\_representation objects. Each Site\_shape\_representation defines the shape of exactly one Site object.

**4.3.186. Site to Sited\_plant**

Each Site has located on it one or more Sited\_plant objects. Each Sited\_plant is located on exactly one Site object.

**4.3.187. Site\_feature to Changed\_site\_feature**

Each Site\_feature is changed by zero, one, or many Changed\_site\_feature objects. Each Changed\_site\_feature changes exactly one Site\_feature.

**4.3.188. Site\_shape\_representation to Breakline**

Each Site\_shape\_representation is constrained by zero, one or many Breakline objects. Each Breakline constrains zero or one Site\_shape\_representation object.

**4.3.189. Site\_shape\_representation to Gis\_position**

Each Site\_shape\_representation has a global position defined by zero or one Gis\_position. Each Gis\_position defines the global position for exactly one Site\_shape\_representation object.

**4.3.190. Sited\_plant to Changed\_sited\_plant**

Each Sited\_plant is changed by zero, one, or many Changed\_sited\_plant objects. Each Changed\_sited\_plant changes exactly one Sited\_plant.

#### **4.3.191. Stream\_design\_case to Line\_less\_piping\_system**

Each Stream\_design\_case transports material for zero, one or many Line\_less\_piping\_system objects. Each Line\_less\_piping\_system is associated with zero, one or many Stream\_design\_case objects.

#### **4.3.192. Stream\_design\_case to Piping\_system\_line\_segment**

Each Stream\_design\_case defines transport needs for zero, one or many Piping\_system\_line\_segment objects. Each Piping\_system\_line\_segment defines potential material for zero, one or many Stream\_design\_case objects.

#### **4.3.193. Stream\_design\_case to Service\_operating\_case**

Each Stream\_design\_case defines zero, one or many Service\_operating\_case objects. Each Service\_operating\_case is defined by exactly one Stream\_design\_case object.

#### **4.3.194. Stream\_design\_case to Stream\_phase**

Each Stream\_design\_case is composed of one or more Stream\_phase objects. Each Stream\_phase is defined by exactly one Stream\_design\_case object.

#### **4.3.195. Sub\_plant\_relationship to Changed\_sub\_plant\_relationship**

Each Sub\_plant\_relationship is changed by zero, one or many Changed\_sub\_plant\_relationship objects. Each Changed\_sub\_plant\_relationship changes exactly one Sub\_plant\_relationship.

#### **4.3.196. Supplier to Catalogue\_definition**

Each Supplier publishes zero, one or many Catalogue\_definition objects. Each Catalogue\_definition is published by zero or one Supplier object.

#### **4.3.197. Supplier to Supplied\_equipment**

Each Supplier supplies one or more Supplied\_equipment objects. Each Supplied\_equipment is supplied by exactly one Supplier object.

#### **4.3.198. Support\_constraints to Support\_usage**

Each Support\_constraints constrains the motion in the negative x-direction of zero, one or many Support\_usage objects. Each Support\_usage has motion in the negative x-direction constrained by zero or one Support\_constraints object.

Each Support\_constraints constrains the motion in the positive x-direction of zero, one or many Support\_usage objects. Each Support\_usage has motion in the positive x-direction constrained by zero or one Support\_constraints object.

Each `Support_constraints` constrains the motion in the negative y-direction of zero, one or many `Support_usage` objects. Each `Support_usage` has motion in the negative y-direction constrained by zero or one `Support_constraints` object.

Each `Support_constraints` constrains the motion in the positive y-direction of zero, one or many `Support_usage` objects. Each `Support_usage` has motion in the positive y-direction constrained by zero or one `Support_constraints` object.

Each `Support_constraints` constrains the motion in the negative z-direction of zero, one or many `Support_usage` objects. Each `Support_usage` has motion in the negative z-direction constrained by zero or one `Support_constraints` object.

Each `Support_constraints` constrains the motion in the positive z-direction of zero, one or many `Support_usage` objects. Each `Support_usage` has motion in the positive z-direction constrained by zero or one `Support_constraints` object.

Each `Support_constraints` constrains the negative rotation about the x-axis of zero, one or many `Support_usage` objects. Each `Support_usage` has the negative rotation about the x-axis constrained by zero or one `Support_constraints` object.

Each `Support_constraints` constrains the positive rotation about the x-axis of zero, one or many `Support_usage` objects. Each `Support_usage` has the positive rotation about the x-axis constrained by zero or one `Support_constraints` object.

Each `Support_constraints` constrains the negative rotation about the y-axis of zero, one or many `Support_usage` objects. Each `Support_usage` has the negative rotation about the y-axis constrained by zero or one `Support_constraints` object.

Each `Support_constraints` constrains the positive rotation about the y-axis of zero, one or many `Support_usage` objects. Each `Support_usage` has the positive rotation about the y-axis constrained by zero or one `Support_constraints` object.

Each `Support_constraints` constrains the negative rotation about the z-axis of zero, one or many `Support_usage` objects. Each `Support_usage` has the negative rotation about the z-axis constrained by zero or one `Support_constraints` object.

Each `Support_constraints` constrains the positive rotation about the z-axis of zero, one or many `Support_usage` objects. Each `Support_usage` has the positive rotation about the z-axis constrained by zero or one `Support_constraints` object.

#### **4.3.199. `Support_usage_connection` to `Plant_item_connection_occurrence`**

Each `Support_usage_connection` is detailed by zero, one or many.

`Plant_item_connection_occurrence` objects. Each `Plant_item_connection_occurrence` gives the details for zero or one `Support_usage_connection` object.

## 5 Application interpreted model

### 5.1 Mapping specification

This clause contains the mapping specification that shows how each UoF, application object, and attribute of this part of ISO 10303 (see clause 4) maps to one or more AIM constructs (see annex A). The mapping specification contains up to five items for each application object or attribute. These include: Application element; AIM element; Source; Rules; and Reference path.

**Application element:** Name of an application element as it appears in the application object definition in clause 4.2. Application object names begin with an upper case letter. Attribute names and assertions are listed after the application object to which they belong and are written in lower case.

**AIM element:** Name of an AIM element as it appears in the AIM (see annex A), the term 'IDENTICAL MAPPING', or the term 'PATH'. AIM entities are written in lower case. Attribute names of AIM entities are referred to as <entity name>.<attribute name>. The mapping of an application element may result in several related AIM elements. Each of these AIM elements requires an entry of its own in the specification. The term 'IDENTICAL MAPPING' indicates that both application objects of an application assertion map to the same AIM element. The term 'PATH' indicates that the application assertion maps to the entire reference path.

**Source:** For those AIM elements that are interpreted from the integrated resources, this is the number of the corresponding part of ISO 10303. For those AIM elements that are created for the purpose of this part of ISO 10303, this is the number of the part. For those AIM elements that are directly incorporated from an application interpreted construct (AIC), this is the AIC reference.

**Rules:** One or more numbers may be given that refer to rules that apply to the current AIM element or reference path. For rules that are derived from relationships between application objects, the same rule is referred to by the mapping entries of all the involved AIM elements. The expanded names of the rules are listed in the specification.

**Reference path:** To describe fully the mapping of an application object, it may be necessary to specify a reference path through several related AIM elements. The reference path documents the role of an AIM element relative to the AIM element in the row succeeding it. Two or more such related AIM elements define the interpretation of the integrated resources that satisfies the requirement specified by the application object. For each AIM element that has been created for use within this part of ISO 10303, a reference path up to its supertype from an integrated resource is specified.

For the expression of reference paths and the relationships between AIM elements the following notational conventions apply:

- a) []: multiple AIM elements or sections of the reference path are required to satisfy an information requirement;
- b) (): multiple AIM elements or sections of the reference path are identified as alternatives within the mapping to satisfy an information requirement;
- c) {}: enclosed section constrains the reference path to satisfy an informational requirement;
- d) ->: attribute references the entity or select type given in the following entry;
- e) <-: entity or select type is referenced by the attribute in the following entry;

- f) [i]: attribute is an aggregation of which a single member is given in the following entry;
- g) [n]: attribute is an aggregation of which member n is given in the following entry;
- h) =>: entity is a supertype of the entity given in the following entry;
- i) <=: entity is a subtype of the entity given in the following entry;
- j) =: the string, select, or enumeration type is constrained to a choice or value;
- k) \: line continuation for strings that wrap.

## 5.1.1 Cableway\_component\_characterization UoF

### 5.1.1.1 Cable

AIM element: product

Source: 41

Rules: dependent\_instantiable\_product\_context  
product\_context\_discipline\_type\_constraint  
value\_for\_application\_context

Reference path: {[product  
classification\_item = product  
classification\_item <-  
applied\_classification\_assignment.items[i]  
applied\_classification\_assignment <=  
classification\_assignment  
classification\_assignment.assigned\_classification ->  
[group  
group.name = 'cable']  
[group <-  
group\_relationship.related\_group  
group\_relationship  
group\_relationship.relating\_group ->  
group  
group.name = 'electrical component']  
[product  
product.frame\_of\_reference[i] ->  
product\_context<=  
application\_context\_element  
application\_context\_element.name = 'plant item']]}

### 5.1.1.2 Cableway\_component

AIM element: product

Source: 41

Rules: dependent\_instantiable\_product\_context  
product\_context\_discipline\_type\_constraint  
value\_for\_application\_context

Reference path: {[product  
classification\_item = product  
classification\_item <-  
applied\_classification\_assignment.items[i]  
applied\_classification\_assignment <=  
classification\_assignment

```

classification_assignment.assigned_classification ->
group
group.name = 'cableway component']
[product
product.frame_of_reference[i] ->
product_context <=
application_context_element
application_context_element.name = 'plant item']]

```

### 5.1.1.2.1 cableway\_component to cable

AIM element: PATH

Reference path:

```

product <-
product_definition_formation.of_product
product_definition_formation <-
product_definition.formation
product_definition <-
product_definition_relationship.relatng_product_definition
product_definition_relationship
{product_definition_relationship.name = 'cable containment'}
product_definition_relationship.related_product_definition ->
product_definition
product_definition.formation ->
product_definition_formation
product_definition_formation.of_product ->
product

```

### 5.1.1.3 Cableway\_connector

AIM element: plant\_item\_connector

Source: 227

Reference path:

```

plant_item_connector <=
shape_aspect
{plant_item_connector
classification_item = plant_item_connector
classification_item <-
applied_classification_assignment.items[i]
applied_classification_assignment <=
{classification_assignment
classification_assignment.role ->
classification_role
classification_role.name = 'cableway connector type classification'}
classification_assignment
classification_assignment.assigned_classification ->
group =>
cableway_connector_class}

```

#### 5.1.1.3.1 type

AIM element: group.name

Source: 41

Reference path: plant\_item\_connector  
classification\_item = plant\_item\_connector  
classification\_item <-  
applied\_classification\_assignment.items[i]  
applied\_classification\_assignment <=  
{classification\_assignment  
classification\_assignment.role ->  
classification\_role  
classification\_role.name = 'cableway connector type classification'}  
classification\_assignment  
classification\_assignment.assigned\_classification ->  
{group =>  
cableway\_connector\_class}  
group  
group.name

#### 5.1.1.4 Cableway\_fitting

AIM element: cableway\_component\_definition

Source: 227

Rules: dependent\_instantiable\_product\_context  
product\_context\_discipline\_type\_constraint  
value\_for\_application\_context

Reference path: cableway\_component\_definition <=  
product\_definition  
{cableway\_component\_definition  
classification\_item = cableway\_component\_definition  
classification\_item <-  
applied\_classification\_assignment.items[i]  
applied\_classification\_assignment <=  
classification\_assignment  
classification\_assignment.assigned\_classification ->  
group  
group.name = 'cableway fitting'}  
{product\_definition  
product\_definition.formation ->  
product\_definition\_formation  
product\_definition\_formation.of\_product ->  
[product  
classification\_item = product  
classification\_item <-  
applied\_classification\_assignment.items[i]  
applied\_classification\_assignment <=  
classification\_assignment  
classification\_assignment.assigned\_classification ->  
(group)

```
(group <-
group_relationship.related_group
group_relationship
group_relationship.relating_group ->
group)
group.name = 'cableway component']
[product
product.frame_of_reference[i] ->
product_context <=
application_context_element
application_context_element.name = 'plant item']])
```

### 5.1.1.5 Cableway\_piece

AIM element: cableway\_component\_definition

Source: 227

Rules: dependent\_instantiable\_product\_context  
product\_context\_discipline\_type\_constraint  
value\_for\_application\_context

Reference path: cableway\_component\_definition <=
product\_definition
{cableway\_component\_definition
classification\_item = cableway\_component\_definition
classification\_item <-
applied\_classification\_assignment.items[i]
applied\_classification\_assignment <=
classification\_assignment
classification\_assignment.assigned\_classification ->
group
group.name = 'cableway piece'}
{product\_definition
product\_definition.formation ->
product\_definition\_formation
product\_definition\_formation.of\_product ->
[product
classification\_item = product
classification\_item <-
applied\_classification\_assignment.items[i]
applied\_classification\_assignment <=
classification\_assignment
classification\_assignment.assigned\_classification ->
(group)
(group <-
group\_relationship.related\_group
group\_relationship
group\_relationship.relating\_group ->
group)
group.name = 'cableway component']
[product
product.frame\_of\_reference[i] ->

```

product_context <=
application_context_element
application_context_element.name = 'plant item'])

```

### 5.1.1.6 Cableway\_size\_description

AIM element: representation

Source: 43

Reference path: {representation  
(representation.name = 'cableway size description')  
(representation.name = 'conduit size description')  
(representation.name = 'raceway size description')}

#### 5.1.1.6.1 fill\_area

AIM element: [measure\_with\_unit.value\_component]  
[measure\_with\_unit.unit\_component]

Source: 41

Reference path representation  
(representation.items[i] ->  
{representation\_item  
(representation\_item.name = 'maximum fill area')  
(representation\_item.name = 'minimum fill area'}})  
([representation.items[i] ->  
{representation\_item  
representation\_item.name = 'maximum fill area'}]  
[representation.items[i] ->  
{representation\_item  
representation\_item.name = 'minimum fill area'}}]))  
(representation.items[i] ->  
representation\_item =>  
{representation\_item.name = 'fill area'}})  
measure\_representation\_item <=  
{measure\_with\_unit =>  
area\_measure\_with\_unit}  
measure\_with\_unit  
[measure\_with\_unit.value\_component]  
[measure\_with\_unit.unit\_component]

#### 5.1.1.6.2 cableway\_size\_description to cableway\_component

AIM element: PATH

Reference path: representation <-  
property\_definition\_representation.using\_representation  
property\_definition\_representation  
property\_definition\_representation.definition ->  
represented\_definition  
represented\_definition = property\_definition

```

property_definition.definition ->
characterized_definition
characterized_definition = characterized_product_definition
characterized_product_definition
characterized_product_definition = product_definition
product_definition
{product_definition =>
cableway_component_definition}
product_definition.formation ->
product_definition_formation
product_definition_formation.of_product ->
product

```

### 5.1.1.6.3 cableway\_size\_description to cableway\_connector

AIM element: PATH

Reference path:

```

representation <-
property_definition_representation.using_representation
property_definition_representation
property_definition_representation.definition ->
represented_definition
represented_definition = property_definition
property_definition.definition ->
characterized_definition
characterized_definition = shape_definition
shape_definition
shape_definition = shape_aspect
shape_aspect =>
plant_item_connector

```

### 5.1.1.7 Conduit

AIM element: cableway\_component\_definition

Source: 227

Rules:

```

dependent_instantiable_product_context
product_context_discipline_type_constraint
value_for_application_context

```

Reference path:

```

cableway_component_definition <=
product_definition
{cableway_component_definition
classification_item = cableway_component_definition
classification_item <-
applied_classification_assignment.items[i]
applied_classification_assignment <=
classification_assignment
classification_assignment.assigned_classification ->
[group =>
cableway_component_class]

```

```

[group
group.name = 'conduit']]
{product_definition
product_definition.formation ->
product_definition_formation
product_definition_formation.of_product ->
[product
classification_item = product
classification_item <-
applied_classification_assignment.items[i]
applied_classification_assignment <=
classification_assignment
classification_assignment.assigned_classification ->
(group)
(group <-
group_relationship.related_group
group_relationship
group_relationship.relate_group ->
group)
group.name = 'cableway component']
[product
product.frame_of_reference[i] ->
product_context <=
application_context_element
application_context_element.name = 'plant item']])

```

### 5.1.1.8 Conduit\_size\_description

AIM element: representation

Source: 43

Reference path: {representation  
representation.name = 'conduit size description'}

#### 5.1.1.8.1 outer\_diameter

AIM element: [measure\_with\_unit.value\_component]  
[measure\_with\_unit.unit\_component]

Source: 41

Reference path representation  
(representation.items[i] ->  
{representation\_item  
(representation\_item.name = 'maximum outer diameter')  
(representation\_item.name = 'minimum outer diameter'}})  
([representation.items[i] ->  
{representation\_item  
representation\_item.name = 'maximum outer diameter'}}]  
[representation.items[i] ->  
{representation\_item  
representation\_item.name = 'minimum outer diameter'}}))

```

(representation.items[i] ->
representation_item =>
{representation_item.name = 'outer diameter'})
measure_representation_item <=
{measure_with_unit =>
length_measure_with_unit}
measure_with_unit
[measure_with_unit.value_component]
[measure_with_unit.unit_component]

```

#### 5.1.1.8.2 inner\_diameter

AIM element: [measure\_with\_unit.value\_component]  
[measure\_with\_unit.unit\_component]

Source: 41

Reference path representation  
(representation.items[i] ->  
{representation\_item  
(representation\_item.name = 'maximum inner diameter')  
(representation\_item.name = 'minimum inner diameter'}})  
([representation.items[i] ->  
{representation\_item  
representation\_item.name = 'maximum inner diameter'}}]  
[representation.items[i] ->  
{representation\_item  
representation\_item.name = 'minimum inner diameter'}}])  
(representation.items[i] ->  
representation\_item =>  
{representation\_item.name = 'inner diameter'})  
measure\_representation\_item <=  
{measure\_with\_unit =>  
length\_measure\_with\_unit}  
measure\_with\_unit  
[measure\_with\_unit.value\_component]  
[measure\_with\_unit.unit\_component]

#### 5.1.1.8.3 thickness

AIM element: [measure\_with\_unit.value\_component]  
[measure\_with\_unit.unit\_component]

Source: 41

Reference path representation  
(representation.items[i] ->  
{representation\_item  
(representation\_item.name = 'maximum thickness')  
(representation\_item.name = 'minimum thickness'}})  
([representation.items[i] ->  
{representation\_item  
representation\_item.name = 'maximum thickness'}}]

```

[representation.items[i] ->
{representation_item
representation_item.name = 'minimum thickness'}}))
(representation.items[i] ->
representation_item =>
{representation_item.name = 'thickness'})
measure_representation_item <=
{measure_with_unit =>
length_measure_with_unit}
measure_with_unit
[measure_with_unit.value_component]
[measure_with_unit.unit_component]

```

### 5.1.1.9 Raceway

AIM element: cableway\_component\_definition

Source: 227

Rules: dependent\_instantiable\_product\_context  
product\_context\_discipline\_type\_constraint  
value\_for\_application\_context

Reference path: cableway\_component\_definition <=

```

product_definition
{cableway_component_definition
classification_item = cableway_component_definition
classification_item <-
applied_classification_assignment.items[i]
applied_classification_assignment <=
classification_assignment
classification_assignment.assigned_classification ->
[group =>
cableway_component_class]
[group
group.name = 'raceway']}
{product_definition
product_definition.formation ->
product_definition_formation
product_definition_formation.of_product ->
[product
classification_item = product
classification_item <-
applied_classification_assignment.items[i]
applied_classification_assignment <=
classification_assignment
classification_assignment.assigned_classification ->
(group)
(group <-
group_relationship.related_group
group_relationship
group_relationship.relate_group ->
group)

```

```

group.name = 'cableway component']
[product
product.frame_of_reference[i] ->
product_context <=
application_context_element
application_context_element.name = 'plant item']]

```

### 5.1.1.9.1 raceway to raceway\_lane

AIM element: PATH

Reference path: cableway\_component\_definition <=  
product\_definition <-  
product\_definition\_relationship.relating\_product\_definition  
product\_definition\_relationship  
product\_definition\_relationship.related\_product\_definition ->  
product\_definition =>  
cableway\_component\_definition

### 5.1.1.10 Raceway\_lane

AIM element: cableway\_component\_definition

Source: 227

Rules: dependent\_instantiable\_product\_context  
product\_context\_discipline\_type\_constraint  
value\_for\_application\_context

Reference path: cableway\_component\_definition <=  
product\_definition  
{cableway\_component\_definition  
classification\_item = cableway\_component\_definition  
classification\_item <-  
applied\_classification\_assignment.items[i]  
applied\_classification\_assignment <=  
classification\_assignment  
classification\_assignment.assigned\_classification ->  
[group =>  
cableway\_component\_class]  
[group  
group.name = 'raceway lane']}  
{product\_definition  
product\_definition.formation ->  
product\_definition\_formation  
product\_definition\_formation.of\_product ->  
[product  
classification\_item = product  
classification\_item <-  
applied\_classification\_assignment.items[i]  
applied\_classification\_assignment <=  
classification\_assignment

```

classification_assignment.assigned_classification ->
(group)
(group <-
group_relationship.related_group
group_relationship
group_relationship.relying_group ->
group)
group.name = 'cableway component']
[product
product.frame_of_reference[i] ->
product_context <=
application_context_element
application_context_element.name = 'plant item']]

```

### 5.1.1.11 Raceway\_size\_description

AIM element: representation

Source: 43

Reference path: {representation  
representation.name = 'raceway size description'}

#### 5.1.1.11.1 outer\_width

AIM element: [measure\_with\_unit.value\_component]  
[measure\_with\_unit.unit\_component]

Source: 41

Reference path representation  
(representation.items[i] ->  
{representation\_item  
(representation\_item.name = 'maximum outer width')  
(representation\_item.name = 'minimum outer width'}})  
([representation.items[i] ->  
{representation\_item  
representation\_item.name = 'maximum outer width'}}]  
[representation.items[i] ->  
{representation\_item  
representation\_item.name = 'minimum outer width'}}]))  
(representation.items[i] ->  
representation\_item =>  
{representation\_item.name = 'outer width'}})  
measure\_representation\_item <=  
{measure\_with\_unit =>  
length\_measure\_with\_unit}  
measure\_with\_unit  
[measure\_with\_unit.value\_component]  
[measure\_with\_unit.unit\_component]

**5.1.1.11.2 outer\_height**

AIM element: [measure\_with\_unit.value\_component]  
[measure\_with\_unit.unit\_component]

Source: 41

Reference path representation  
(representation.items[i] ->  
{representation\_item  
(representation\_item.name = 'maximum outer height')  
(representation\_item.name = 'minimum outer height'}})  
([representation.items[i] ->  
{representation\_item  
representation\_item.name = 'maximum outer height'}}]  
[representation.items[i] ->  
{representation\_item  
representation\_item.name = 'minimum outer height'}}])  
(representation.items[i] ->  
representation\_item =>  
{representation\_item.name = 'outer height'})  
measure\_representation\_item <=  
{measure\_with\_unit =>  
length\_measure\_with\_unit}  
measure\_with\_unit  
[measure\_with\_unit.value\_component]  
[measure\_with\_unit.unit\_component]

**5.1.1.11.3 inner\_width**

AIM element: [measure\_with\_unit.value\_component]  
[measure\_with\_unit.unit\_component]

Source: 41

Reference path representation  
(representation.items[i] ->  
{representation\_item  
(representation\_item.name = 'maximum inner width')  
(representation\_item.name = 'minimum inner width'}})  
([representation.items[i] ->  
{representation\_item  
representation\_item.name = 'maximum inner width'}}]  
[representation.items[i] ->  
{representation\_item  
representation\_item.name = 'minimum inner width'}}])  
(representation.items[i] ->  
representation\_item =>  
{representation\_item.name = 'inner width'})  
measure\_representation\_item <=  
{measure\_with\_unit =>  
length\_measure\_with\_unit}  
measure\_with\_unit

[measure\_with\_unit.value\_component]  
[measure\_with\_unit.unit\_component]

#### 5.1.1.11.4 inner\_height

AIM element: [measure\_with\_unit.value\_component]  
[measure\_with\_unit.unit\_component]

Source: 41

Reference path representation  
(representation.items[i] ->  
{representation\_item  
(representation\_item.name = 'maximum inner height')  
(representation\_item.name = 'minimum inner height'}})  
([representation.items[i] ->  
{representation\_item  
representation\_item.name = 'maximum inner height'}}]  
[representation.items[i] ->  
{representation\_item  
representation\_item.name = 'minimum inner height'}}])  
(representation.items[i] ->  
representation\_item =>  
{representation\_item.name = 'inner height'})  
measure\_representation\_item <=  
{measure\_with\_unit =>  
length\_measure\_with\_unit}  
measure\_with\_unit  
[measure\_with\_unit.value\_component]  
[measure\_with\_unit.unit\_component]

### 5.1.2 Change\_Information UoF

#### 5.1.2.1 Change

AIM element: change\_action

Source: 227

Reference path: change\_action <=  
directed\_action

##### 5.1.2.1.1 business\_unit

AIM element: organization.name

Source: 41

Reference path: change\_action  
plant\_spatial\_configuration\_organization\_item = change\_action  
plant\_spatial\_configuration\_organization\_item <-  
plant\_spatial\_configuration\_organization\_assignment.items[i]

```

plant_spatial_configuration_organization_assignment <=
organization_assignment
organization_assignment.assigned_organization ->
organization
organization.name

```

#### **5.1.2.1.2 change\_id**

AIM element: action.name

Source: 41

Reference path: change\_action <=  
directed\_action <=  
executed\_action <=  
action  
action.name

#### **5.1.2.1.3 change\_reason**

AIM element: action\_method.purpose

Source: 41

Reference path: change\_action <=  
directed\_action <=  
executed\_action <=  
action  
action.chosen\_method ->  
action\_method  
action\_method.purpose

#### **5.1.2.1.4 change\_summary**

AIM element: action\_method.description

Source: 41

Reference path: change\_action <=  
directed\_action <=  
executed\_action <=  
action  
action.chosen\_method ->  
action\_method  
action\_method.description

#### **5.1.2.1.5 date**

AIM element: (calendar\_date)  
([calendar\_date]  
[local\_time])

Source: 41

Rules: change\_action\_requires\_date

Reference path: change\_action  
 (dated\_item = change\_action  
 dated\_item <-  
 applied\_date\_assignment.items[i]  
 applied\_date\_assignment <=  
 date\_assignment  
 date\_assignment.assigned\_date ->  
 date =>  
 calendar\_date)  
 (date\_and\_time\_item = change\_action  
 date\_and\_time\_item <-  
 applied\_date\_and\_time\_assignment.items[i]  
 applied\_date\_and\_time\_assignment  
 applied\_date\_and\_time\_assignment.assigned\_date\_and\_time ->  
 date\_and\_time  
 [date\_and\_time.date\_component ->  
 date =>  
 calendar\_date]  
 [date\_and\_time.time\_component ->  
 local\_time])

#### 5.1.2.1.6 project\_number

AIM element: organizational\_project.name

Source: 41

Reference path: change\_action  
 plant\_spatial\_configuration\_organization\_item = change\_action  
 plant\_spatial\_configuration\_organization\_item <-  
 plant\_spatial\_configuration\_organization\_assignment.items[i]  
 plant\_spatial\_configuration\_organization\_assignment <=  
 organization\_assignment  
 organization\_assignment.assigned\_organization ->  
 organization <-  
 organizational\_project.responsible\_organizations[i]  
 organizational\_project  
 organizational\_project.name

#### 5.1.2.1.7 revision

AIM element: action\_relationship

Source: 41

Reference path: change\_action <=  
 directed\_action <=  
 executed\_action <=  
 action <-

```
(action_relationship.relate_action)
(action_relationship.related_action)
{action_relationship
action_relationship.name = 'change revision'}
action_relationship
```

#### 5.1.2.1.8 title

AIM element: action\_method.name

Source: 41

Reference path: change\_action <=  
directed\_action <=  
executed\_action <=  
action  
action.chosen\_method ->  
action\_method  
action\_method.name

#### 5.1.2.1.9 change to change\_item

AIM element: PATH

Reference path: change\_action <=  
directed\_action <=  
executed\_action <=  
action <-  
action\_assignment.assigned\_action  
action\_assignment =>  
plant\_spatial\_configuration\_change\_assignment  
plant\_spatial\_configuration\_change\_assignment.items[i] ->  
change\_item

#### 5.1.2.1.10 change to change\_life\_cycle\_stage\_usage

AIM element: PATH

Rules: version2\_p41\_object\_role\_selection

Reference path: change\_action <=  
directed\_action  
directed\_action.directive ->  
action\_directive  
action\_directive.requests[i] ->  
versioned\_action\_request

### 5.1.2.2 Change\_approval

AIM element: applied\_approval\_assignment

Source: 227

Rules: change\_life\_cycle\_stage\_usage\_requires\_approval

Reference path: applied\_approval\_assignment <=  
approval\_assignment

#### 5.1.2.2.1 approval\_date

AIM element: (calendar\_date)  
([calendar\_date]  
[local\_time])

Source: 41

Rules: approval\_requires\_approval\_date\_time

Reference path: applied\_approval\_assignment <=  
approval\_assignment  
approval\_assignment.assigned\_approval ->  
approval <-  
approval\_date\_time.dated\_approval  
approval\_date\_time  
approval\_date\_time.date\_time ->  
date\_time\_select  
(date\_time\_select = date  
date =>  
calendar\_date)  
(date\_time\_select = date\_and\_time  
date\_and\_time  
[date\_and\_time.date\_component ->  
date =>  
calendar\_date]  
[date\_and\_time.time\_component ->  
local\_time])

#### 5.1.2.2.2 approver

AIM element: person

Source: 41

Rules: approval\_requires\_approval\_person\_organization

Reference path: applied\_approval\_assignment <=  
approval\_assignment  
approval\_assignment.assigned\_approval ->  
approval <-  
approval\_person\_organization.authorized\_approval  
approval\_person\_organization  
approval\_person\_organization.person\_organization ->  
person\_organization\_select  
(person\_organization\_select = person)

```
(person_organization_select = person_and_organization
person_and_organization
person_and_organization.the_person ->
person)
person
```

### 5.1.2.2.3 approver\_role

AIM element: approval\_role.role

Source: 41

Rules: approval\_requires\_approval\_person\_organization

Reference path: applied\_approval\_assignment <=  
approval\_assignment  
approval\_assignment.assigned\_approval ->  
approval <-  
approval\_person\_organization.authorized\_approval  
approval\_person\_organization  
approval\_person\_organization.role ->  
approval\_role  
approval\_role.role

### 5.1.2.3 Change\_item

AIM element: change\_item

Source: 227

Reference path: {change\_item  
(change\_item = line\_branch\_connection)  
(change\_item = line\_plant\_item\_branch\_connection)  
(change\_item = line\_plant\_item\_connection)  
(change\_item = line\_termination\_connection)  
(change\_item = plant)  
(change\_item = axis2\_placement\_2d)  
(change\_item = axis2\_placement\_3d)  
(change\_item = product)  
(change\_item = product\_definition\_relationship)  
(change\_item = reference\_geometry)  
(change\_item = electrical\_system)  
(change\_item = externally\_defined\_plant\_item\_definition)  
(change\_item = ducting\_system)  
(change\_item = instrumentation\_and\_control\_system)  
(change\_item = piping\_system)  
(change\_item = plant\_item\_connection)  
(change\_item = plant\_item\_connector)  
(change\_item = plant\_line\_definition)  
(change\_item = plant\_line\_segment\_definition)  
(change\_item = plant\_line\_segment\_termination)  
(change\_item = process\_capability)  
(change\_item = product\_definition)

```

(change_item = product_definition_shape)
(change_item = sited_plant)
(change_item = structural_system)
(change_item = document)
(change_item = site)
(change_item = site_feature)
(change_item = cableway_system)}

```

### 5.1.2.3.1 **change\_item\_id**

AIM element: change\_item\_id\_assignment

Source: 227

Rules: change\_item\_requires\_id

Reference path: change\_item <-  
change\_item\_id\_assignment.items[i]  
change\_item\_id\_assignment <=  
name\_assignment

### 5.1.2.3.2 **creation\_date**

AIM element: (calendar\_date)

([calendar\_date]  
[local\_time])

Source: 41

Rules: change\_item\_requires\_creation\_date

Reference path: change\_item  
(dated\_item = change\_item  
dated\_item <-  
applied\_date\_assignment.items[i]  
applied\_date\_assignment <=  
{date\_assignment  
date\_assignment.role ->  
date\_role  
date\_role.name = 'creation date'}  
date\_assignment  
date\_assignment.assigned\_date ->  
date =>  
calendar\_date)  
(date\_and\_time\_item = change\_item  
date\_and\_time\_item <-  
applied\_date\_and\_time\_assignment.items[i]  
applied\_date\_and\_time\_assignment <=  
{date\_and\_time\_assignment  
date\_and\_time\_assignment.role ->  
date\_time\_role  
date\_time\_role.name = 'creation date'}

```

date_and_time_assignment
date_and_time_assignment.assigned_date_and_time ->
date_and_time
[date_and_time.date_component ->
date =>
calendar_date]
[date_and_time.time_component ->
local_time])

```

### 5.1.2.3.3 description

AIM element: action.description

Source: 41

Reference path: change\_item <-  
 plant\_spatial\_configuration\_change\_assignment.items[i]  
 plant\_spatial\_configuration\_change\_assignment <=  
 action\_assignment  
 action\_assignment.assigned\_action ->  
 action  
 action.description

### 5.1.2.3.4 item\_owner

AIM element: person\_and\_organization

Source: 41

Reference path: change\_item  
 plant\_spatial\_configuration\_person\_and\_organization\_item = change\_item  
 plant\_spatial\_configuration\_person\_and\_organization\_item <-  
 plant\_spatial\_configuration\_person\_and\_organization\_assignment.items[i]  
 plant\_spatial\_configuration\_person\_and\_organization\_assignment <=  
 {person\_and\_organization\_assignment  
 person\_and\_organization\_assignment.role ->  
 person\_and\_organization\_role  
 person\_and\_organization\_role.name = 'owner'}  
 person\_and\_organization\_assignment  
 person\_and\_organization\_assignment.assigned\_person\_and\_organization ->  
 person\_and\_organization

### 5.1.2.3.5 from\_or\_to

AIM element: object\_role.name

Source: 41

Rules: version2\_p41\_object\_role\_selection

Reference path: change\_item <-  
 plant\_spatial\_configuration\_change\_assignment.items[i]  
 plant\_spatial\_configuration\_change\_assignment <=

```

action_assignment
role_select = action_assignment
role_select <-
role_association.item_with_role
role_association
role_association.role ->
object_role
object_role.name
{(object_role.name = 'from')
(object_role.name = 'to')}

```

#### 5.1.2.3.6 **supersedence\_status**

AIM element:      action\_status.status

Source:            41

Reference path:    change\_item <-  
                      plant\_spatial\_configuration\_change\_assignment.items[i]  
                      plant\_spatial\_configuration\_change\_assignment <=  
                      action\_assignment  
                      action\_assignment.assigned\_action ->  
                      action =>  
                      executed\_action <-  
                      action\_status.assigned\_action  
                      action\_status  
                      action\_status.status

#### 5.1.2.4 **Change\_life\_cycle\_stage**

AIM element:      group

Source:            41

##### 5.1.2.4.1 **name**

AIM element:      group.name

Source:            41

##### 5.1.2.4.2 **change\_life\_cycle\_stage to change\_life\_cycle\_stage\_sequence (as predecessor)**

AIM element:      PATH

Reference path:    group <-  
                      group\_relationship.relatng\_group  
                      {group\_relationship  
                      group\_relationship.name = 'change life cycle stage sequence'}  
                      group\_relationship

### 5.1.2.4.3 **change\_life\_cycle\_stage to change\_life\_cycle\_stage\_sequence (as successor)**

AIM element: PATH

Reference path: `group <-  
group_relationship.related_group  
{group_relationship  
group_relationship.name = 'change life cycle stage sequence'}  
group_relationship`

### 5.1.2.4.4 **change\_life\_cycle\_stage to change\_life\_cycle\_stage\_usage**

AIM element: PATH

Rules: `change_life_cycle_stage_usage_requires_stage`

Reference path: `group <-  
group_assignment.assigned_group  
group_assignment =>  
change_life_cycle_stage_assignment`

### 5.1.2.5 **Change\_life\_cycle\_stage\_sequence**

AIM element: `group_relationship`

Source: 41

Reference path: `{group_relationship  
group_relationship.name = 'change life cycle stage sequence'}`

### 5.1.2.6 **Change\_life\_cycle\_stage\_usage**

AIM element: `change_life_cycle_stage_assignment`

Source: 227

Reference path: `change_life_cycle_stage_assignment <=  
group_assignment`

#### 5.1.2.6.1 **date\_of\_activation**

AIM element: `(calendar_date)  
([calendar_date]  
[local_time])`

Source: 41

Reference path: `change_life_cycle_stage_assignment  
(dated_item = change_life_cycle_stage_assignment  
dated_item <-  
applied_date_assignment.items[i]`

```

applied_date_assignment <=
{ date_assignment
date_assignment.role ->
date_role
date_role.name = 'activation date'}
date_assignment
date_assignment.assigned_date ->
date =>
calendar_date)
(date_and_time_item = change_life_cycle_stage_assignment
date_and_time_item <-
applied_date_and_time_assignment.items[i]
applied_date_and_time_assignment <=
{ date_and_time_assignment
date_and_time_assignment.role ->
date_time_role
date_time_role.name = 'activation date'}
date_and_time_assignment
date_and_time_assignment.assigned_date_and_time ->
date_and_time
[date_and_time.date_component ->
date =>
calendar_date]
[date_and_time.time_component ->
local_time])

```

### 5.1.2.6.2 date\_of\_completion

AIM element: (calendar\_date)  
 ([calendar\_date]  
 [local\_time])

Source: 41

Reference path: change\_life\_cycle\_stage\_assignment  
 (dated\_item = change\_life\_cycle\_stage\_assignment  
 dated\_item <-  
 applied\_date\_assignment.items[i]  
 applied\_date\_assignment <=  
 { date\_assignment  
 date\_assignment.role ->  
 date\_role  
 date\_role.name = 'completion date'}  
 date\_assignment  
 date\_assignment.assigned\_date ->  
 date =>  
 calendar\_date)  
 (date\_and\_time\_item = change\_life\_cycle\_stage\_assignment  
 date\_and\_time\_item <-  
 applied\_date\_and\_time\_assignment.items[i]  
 applied\_date\_and\_time\_assignment <=  
 { date\_and\_time\_assignment  
 date\_and\_time\_assignment.role ->  
 date\_time\_role

```

date_time_role.name = 'completion date'}
date_and_time_assignment
date_and_time_assignment.assigned_date_and_time ->
date_and_time
[date_and_time.date_component ->
date =>
calendar_date]
[date_and_time.time_component ->
local_time])

```

### 5.1.2.6.3 description

AIM element: group.description

Source: 41

Reference path: change\_life\_cycle\_stage\_assignment <=  
group\_assignment  
group\_assignment.assigned\_group ->  
group  
group.description

### 5.1.2.6.4 change\_life\_cycle\_stage\_usage to change\_approval

AIM element: PATH

Rules: change\_life\_cycle\_stage\_usage\_requires\_approval

Reference path: change\_life\_cycle\_stage\_assignment  
change\_life\_cycle\_stage\_assignment.items[i] ->  
change\_life\_cycle\_stage\_item  
change\_life\_stage\_item = action\_directive  
action\_directive <-  
directed\_action.directive  
directed\_action =>  
change\_action  
approval\_item = change\_action  
approval\_item <-  
applied\_approval\_assignment.items[i]  
applied\_approval\_assignment

### 5.1.2.7 Changed\_line\_assignment

AIM element: product\_definition\_relationship

Source: 41

Reference path: {product\_definition\_relationship  
change\_item = product\_definition\_relationship}

### 5.1.2.8 Changed\_line\_branch\_connection

AIM element: line\_branch\_connection

Source: 227

Reference path: line\_branch\_connection <=  
shape\_aspect\_relationship  
{line\_branch\_connection  
change\_item = line\_branch\_connection}

#### **5.1.2.9 Changed\_line\_plant\_item\_branch\_connection**

AIM element: line\_plant\_item\_branch\_connection

Source: 227

Reference path: line\_plant\_item\_branch\_connection <=  
shape\_aspect\_relationship  
{line\_plant\_item\_branch\_connection  
change\_item = line\_plant\_item\_branch\_connection}

#### **5.1.2.10 Changed\_line\_plant\_item\_connection**

AIM element: line\_plant\_item\_connection

Source: 227

Reference path: line\_plant\_item\_connection <=  
shape\_aspect\_relationship  
{line\_plant\_item\_connection  
change\_item = line\_plant\_item\_connection}

#### **5.1.2.11 Changed\_line\_to\_line\_connection**

AIM element: line\_termination\_connection

Source: 227

Reference path: line\_termination\_connection <=  
shape\_aspect\_relationship  
{line\_termination\_connection  
change\_item = line\_termination\_connection}

#### **5.1.2.12 Changed\_piping\_specification**

AIM element: document

Source: 41

Reference path: {document  
[document.kind ->  
document\_type  
document\_type.product\_data\_type = 'piping specification']}

[change\_item = document]}

### 5.1.2.13 Changed\_piping\_system\_line

AIM element: plant\_line\_definition

Source: 227

Reference path: plant\_line\_definition <=  
product\_definition\_with\_associated\_documents  
{plant\_line\_definition  
change\_item = plant\_line\_definition}

### 5.1.2.14 Changed\_piping\_system\_line\_segment

AIM element: plant\_line\_segment\_definition

Source: 227

Reference path: plant\_line\_segment\_definition <=  
product\_definition  
{plant\_line\_segment\_definition  
change\_item = plant\_line\_segment\_definition}

### 5.1.2.15 Changed\_piping\_system\_line\_segment\_termination

AIM element: plant\_line\_segment\_termination

Source: 227

Reference path: plant\_line\_segment\_termination <=  
shape\_aspect  
{plant\_line\_segment\_termination  
change\_item = plant\_line\_segment\_termination}

### 5.1.2.16 Changed\_planned\_physical\_plant

AIM element: product\_definition

Source: 41

Reference path: {product\_definition  
[product\_definition.formation ->  
product\_definition\_formation  
product\_definition\_formation.of\_product ->  
product =>  
plant]  
[product\_definition.frame\_of\_reference ->  
product\_definition\_context <=  
application\_context\_element  
application\_context\_element.name = 'physical occurrence']}

```
[change_item = product_definition]]
```

### 5.1.2.17 Changed\_plant

AIM element: plant

Source: 227

Reference path: plant <=  
product  
{plant  
change\_item = plant}

### 5.1.2.18 Changed\_plant\_item

AIM element: (product\_definition)  
(externally\_defined\_plant\_item\_definition)  
(product)

Source: 41

Rules: dependent\_instantiable\_product\_context  
product\_context\_discipline\_type\_constraint  
value\_for\_application\_context

Reference path: ([product\_definition  
change\_item = product\_definition]  
[product\_definition  
product\_definition.formation ->  
product\_definition\_formation  
product\_definition\_formation.of\_product ->  
product  
product.frame\_of\_reference[i] ->  
product\_context<=  
application\_context\_element  
application\_context\_element.name = 'plant item']])  
(externally\_defined\_plant\_item\_definition <=  
[product\_definition]  
[externally\_defined\_item]  
{[externally\_defined\_plant\_item\_definition  
change\_item = externally\_defined\_plant\_item\_definition]  
[externally\_defined\_plant\_item\_definition <=  
product\_definition  
product\_definition.formation ->  
product\_definition\_formation  
product\_definition\_formation.of\_product ->  
product  
product.frame\_of\_reference[i] ->  
product\_context<=  
application\_context\_element  
application\_context\_element.name = 'plant item']])  
([product

```

change_item = product]
[product
product.frame_of_reference[i] ->
product_context<=
application_context_element
application_context_element.name = 'plant item']})

```

### 5.1.2.19 Changed\_plant\_item\_collection

AIM element: product\_definition\_relationship

Source: 41

Reference path: {product\_definition\_relationship  
change\_item = product\_definition\_relationship}

### 5.1.2.20 Changed\_plant\_item\_connection

AIM element: plant\_item\_connection

Source: 227

Reference path: plant\_item\_connection <=  
[shape\_aspect\_relationship]  
[shape\_aspect]  
{plant\_item\_connection  
change\_item = plant\_item\_connection}

### 5.1.2.21 Changed\_plant\_item\_connector

AIM element: plant\_item\_connector

Source: 227

Reference path: plant\_item\_connector <=  
shape\_aspect  
{plant\_item\_connector  
change\_item = plant\_item\_connector}

### 5.1.2.22 Changed\_plant\_item\_location

AIM element: (axis2\_placement\_2d)  
(axis2\_placement\_3d)

Source: 42

Reference path: {(axis2\_placement\_2d  
change\_item = axis2\_placement\_2d)  
(axis2\_placement\_3d  
change\_item = axis2\_placement\_3d)}

**5.1.2.23 Changed\_plant\_item\_shape**

AIM element: product\_definition\_shape

Source: 41

Reference path: {product\_definition\_shape  
change\_item = product\_definition\_shape}

**5.1.2.24 Changed\_plant\_process\_capability**

AIM element: process\_capability

Source: 227

Reference path: process\_capability <=  
property\_definition  
{process\_capability  
change\_item = process\_capability}

**5.1.2.25 Changed\_plant\_system**

AIM element: (electrical\_system)  
(ducting\_system)  
(instrumentation\_and\_control\_system)  
(piping\_system)  
(structural\_system)  
(cableway\_system)

Source: 227

Rules: dependent\_instantiable\_product\_context  
product\_context\_discipline\_type\_constraint  
value\_for\_application\_context

Reference path: (electrical\_system <=)  
(ducting\_system <=)  
(instrumentation\_and\_control\_system <=)  
(piping\_system <=)  
(structural\_system <=)  
(cableway\_system <=)  
product\_definition  
{product\_definition  
product\_definition.formation ->  
product\_definition\_formation  
product\_definition\_formation.of\_product ->  
product  
product.frame\_of\_reference[i] ->  
product\_context<=  
application\_context\_element  
application\_context\_element.name = 'plant system'}  
{(electrical\_system

```

change_item = electrical_system)
(ducting_system
change_item = ducting_system)
(instrumentation_and_control_system
change_item = instrumentation_and_control_system)
(piping_system
change_item = piping_system)
(structural_system
change_item = structural_system)
(cableway_system
change_item = cableway_system)}

```

#### **5.1.2.26 Changed\_reference\_geometry**

AIM element: reference\_geometry

Source: 227

Reference path: reference\_geometry <=  
derived\_shape\_aspect  
{reference\_geometry  
change\_item = reference\_geometry}

#### **5.1.2.27 Changed\_required\_material\_description**

AIM element: product\_definition

Source: 41

Reference path: {product\_definition  
change\_item = product\_definition}

#### **5.1.2.28 Changed\_site**

AIM element: site

Source: 227

Reference path: site <=  
[characterized\_object]  
[property\_definition]  
{site  
change\_item = site}

#### **5.1.2.29 Changed\_site\_feature**

AIM element: site\_feature

Source: 227

Reference path: site\_feature <=  
property\_definition

```
{site_feature
change_item = site_feature}
```

### 5.1.2.30 Changed\_sited\_plant

AIM element:       sited\_plant

Source:             227

Reference path:    sited\_plant <=  
                    property\_definition  
                    {sited\_plant  
                    change\_item = sited\_plant}

### 5.1.2.31 Changed\_sub\_plant\_relationship

AIM element:       product\_definition\_relationship

Source:             41

Reference path:    {product\_definition\_relationship  
                    change\_item = product\_definition\_relationship}

## 5.1.3 Connection UoF

### 5.1.3.1 Connection\_definition

AIM element:       plant\_item\_connection

Source:             227

Reference path:    plant\_item\_connection <=  
                    [shape\_aspect\_relationship]  
                    [shape\_aspect]  
                    {shape\_aspect  
                    shape\_aspect.of\_shape ->  
                    product\_definition\_shape <=  
                    property\_definition  
                    property\_definition.definition ->  
                    characterized\_definition  
                    characterized\_definition = characterized\_product\_definition  
                    characterized\_product\_definition  
                    characterized\_product\_definition = product\_definition  
                    product\_definition  
                    product\_definition.frame\_of\_reference ->  
                    product\_definition\_context <=  
                    application\_context\_element  
                    (application\_context\_element.name = 'functional definition')  
                    (application\_context\_element.name = 'physical definition')}

### 5.1.3.1.1 connection\_definition to connector\_definition

AIM element: PATH

Reference path: (plant\_item\_connection <=  
 shape\_aspect\_relationship  
 [shape\_aspect\_relationship.relate\_shape\_aspect ->]  
 [shape\_aspect\_relationship.related\_shape\_aspect ->]  
 shape\_aspect =>  
 plant\_item\_connector)  
 ([plant\_item\_connection <=  
 shape\_aspect\_relationship  
 [shape\_aspect\_relationship.relate\_shape\_aspect ->]  
 [shape\_aspect\_relationship.related\_shape\_aspect ->]  
 shape\_aspect =>  
 plant\_item\_connector]  
 [plant\_item\_connection <=  
 shape\_aspect <-  
 shape\_aspect\_relationship.relate\_shape\_aspect  
 {shape\_aspect\_relationship.name = 'connection involvement'}  
 shape\_aspect\_relationship  
 shape\_aspect\_relationship.related\_shape\_aspect ->  
 shape\_aspect =>  
 plant\_item\_connector])

### 5.1.3.1.2 connection\_definition to functional\_connection\_definition - satisfaction (as functional requirements)

AIM element: PATH

Reference path: plant\_item\_connection <=  
 {shape\_aspect  
 shape\_aspect.of\_shape ->  
 product\_definition\_shape <=  
 property\_definition  
 property\_definition.definition ->  
 characterized\_definition  
 characterized\_definition = characterized\_product\_definition  
 characterized\_product\_definition  
 characterized\_product\_definition = product\_definition  
 product\_definition  
 product\_definition.frame\_of\_reference ->  
 product\_definition\_context <=  
 application\_context\_element  
 application\_context\_element.name = 'functional definition'}  
 shape\_aspect <-  
 shape\_aspect\_relationship.relate\_shape\_aspect  
 shape\_aspect\_relationship  
 {shape\_aspect\_relationship  
 shape\_aspect\_relationship.name = 'connection definition satisfaction'}

### 5.1.3.1.3 **connection\_definition to functional\_connection\_definition - satisfaction (as requirements)**

AIM element: PATH satisfaction)

Reference path: plant\_item\_connection <=  
 { shape\_aspect  
 shape\_aspect.of\_shape ->  
 product\_definition\_shape <=  
 property\_definition  
 property\_definition.definition ->  
 characterized\_definition  
 characterized\_definition = characterized\_product\_definition  
 characterized\_product\_definition  
 characterized\_product\_definition = product\_definition  
 product\_definition  
 product\_definition.frame\_of\_reference ->  
 product\_definition\_context <=  
 application\_context\_element  
 application\_context\_element.name = 'physical definition'}  
 shape\_aspect <=  
 shape\_aspect\_relationship.related\_shape\_aspect  
 shape\_aspect\_relationship  
 { shape\_aspect\_relationship  
 shape\_aspect\_relationship.name = 'connection definition satisfaction'}

### 5.1.3.1.4 **connection\_definition to plant\_item\_connection\_occurrence**

AIM element: PATH

Reference path: plant\_item\_connection <=  
 shape\_aspect <=  
 shape\_aspect\_relationship.relate\_shape\_aspect  
 { shape\_aspect\_relationship  
 shape\_aspect\_relationship.name = 'usage'}  
 shape\_aspect\_relationship  
 shape\_aspect\_relationship.related\_shape\_aspect ->  
 { shape\_aspect  
 shape\_aspect.of\_shape ->  
 product\_definition\_shape <=  
 property\_definition  
 property\_definition.definition ->  
 characterized\_definition  
 characterized\_definition = characterized\_product\_definition  
 characterized\_product\_definition  
 characterized\_product\_definition = product\_definition  
 product\_definition  
 product\_definition.frame\_of\_reference ->  
 product\_definition\_context <=  
 application\_context\_element  
 (application\_context\_element.name = 'functional occurrence')  
 (application\_context\_element.name = 'physical occurrence')}  
 shape\_aspect =>

plant\_item\_connection

### 5.1.3.2 Electricity\_transference

AIM element: plant\_item\_connection

Source: 227

Reference path: plant\_item\_connection <=  
 [shape\_aspect\_relationship]  
 [shape\_aspect]  
 {plant\_item\_connection  
 classification\_item = plant\_item\_connection  
 classification\_item <=  
 applied\_classification\_assignment.items[i]  
 applied\_classification\_assignment <=  
 classification\_assignment  
 classification\_assignment.assigned\_classification ->  
 [group =>  
 connection\_functional\_class]  
 [group  
 group.name = 'electricity transference']}

### 5.1.3.3 Flexible\_connection

AIM element: plant\_item\_connection

Source: 227

Reference path: plant\_item\_connection <=  
 [shape\_aspect\_relationship]  
 [shape\_aspect]  
 {plant\_item\_connection  
 classification\_item = plant\_item\_connection  
 classification\_item <=  
 applied\_classification\_assignment.items[i]  
 applied\_classification\_assignment <=  
 classification\_assignment  
 classification\_assignment.assigned\_classification ->  
 [group =>  
 connection\_motion\_class]  
 [group  
 group.name = 'flexible']}

### 5.1.3.4 Fluid\_transference

AIM element: plant\_item\_connection

Source: 227

Reference path: plant\_item\_connection <=  
 [shape\_aspect\_relationship]  
 [shape\_aspect]

```

{plant_item_connection
classification_item = plant_item_connection
classification_item <-
applied_classification_assignment.items[i]
applied_classification_assignment <=
classification_assignment
classification_assignment.assigned_classification ->
[group =>
connection_functional_class]
[group
group.name = 'fluid transference']}]

```

### 5.1.3.5 Functional\_connection\_definition\_satisfaction

AIM element: shape\_aspect\_relationship

Source: 41

Reference path: {shape\_aspect\_relationship  
[shape\_aspect\_relationship.name = 'connection definition satisfaction']  
[[shape\_aspect\_relationship.relate\_shape\_aspect ->]  
[shape\_aspect\_relationship.related\_shape\_aspect ->]  
{shape\_aspect  
shape\_aspect.of\_shape ->  
product\_definition\_shape <=  
property\_definition  
property\_definition.definition ->  
characterized\_definition  
characterized\_definition = characterized\_product\_definition  
characterized\_product\_definition  
characterized\_product\_definition = product\_definition  
product\_definition  
product\_definition.frame\_of\_reference ->  
product\_definition\_context <=  
application\_context\_element  
(application\_context\_element.name = 'functional definition')  
(application\_context\_element.name = 'physical definition')}  
shape\_aspect =>  
plant\_item\_connection]]}

### 5.1.3.6 Functional\_connection\_occurrence\_satisfaction

AIM element: shape\_aspect\_relationship

Source: 41

Reference path: {shape\_aspect\_relationship  
[shape\_aspect\_relationship.name = 'connection occurrence satisfaction']  
[[shape\_aspect\_relationship.relate\_shape\_aspect ->]  
[shape\_aspect\_relationship.related\_shape\_aspect ->]  
{shape\_aspect  
shape\_aspect.of\_shape ->  
product\_definition\_shape <=

```

property_definition
property_definition.definition ->
characterized_definition
characterized_definition = characterized_product_definition
characterized_product_definition
characterized_product_definition = product_definition
product_definition
product_definition.frame_of_reference ->
product_definition_context <=
application_context_element
(application_context_element.name = 'functional occurrence')
(application_context_element.name = 'physical occurrence')
shape_aspect =>
plant_item_connection]]}

```

### 5.1.3.7 Load\_transference

AIM element: plant\_item\_connection

Source: 227

Reference path: plant\_item\_connection <=

```

[shape_aspect_relationship]
[shape_aspect]
{plant_item_connection
classification_item = plant_item_connection
classification_item <-
applied_classification_assignment.items[i]
applied_classification_assignment <=
classification_assignment
classification_assignment.assigned_classification ->
[group =>
connection_functional_class]
[group
group.name = 'load transference']}]

```

### 5.1.3.8 Locked\_orientation\_connection

AIM element: plant\_item\_connection

Source: 227

Reference path: plant\_item\_connection <=

```

[shape_aspect_relationship]
[shape_aspect]
{plant_item_connection
classification_item = plant_item_connection
classification_item <-
applied_classification_assignment.items[i]
applied_classification_assignment <=
classification_assignment
classification_assignment.assigned_classification ->
[group =>

```

```

connection_motion_class]
[group
group.name = 'locked orientation']]

```

### 5.1.3.9 Plant\_item\_connection

AIM element: plant\_item\_connection

Source: 227

Reference path:

```

plant_item_connection <=
[shape_aspect_relationship]
[shape_aspect]
{plant_item_connection
classification_item = plant_item_connection
classification_item <-
applied_classification_assignment.items[i]
applied_classification_assignment <=
classification_assignment
classification_assignment.assigned_classification ->
[group =>
connection_motion_class]
[group
(group.name = 'flexible')
(group.name = 'locked orientation')]}
{shape_aspect
shape_aspect.of_shape ->
product_definition_shape <=
property_definition
property_definition.definition ->
characterized_definition
characterized_definition = characterized_product_definition
characterized_product_definition
characterized_product_definition = product_definition
product_definition
product_definition.frame_of_reference ->
product_definition_context <=
application_context_element
(application_context_element.name = 'functional definition')
(application_context_element.name = 'physical definition')
(application_context_element.name = 'functional occurrence')
(application_context_element.name = 'physical occurrence')}

```

#### 5.1.3.9.1 additional\_length

AIM element: [measure\_with\_unit.value\_component]  
[measure\_with\_unit.unit\_component]

Source: 41

Rules: subtype\_exclusive\_characterized\_object  
subtype\_mandatory\_shape\_representation

Reference path: plant\_item\_connection <=  
 shape\_aspect\_relationship  
 shape\_definition = shape\_aspect\_relationship  
 characterized\_definition = shape\_definition  
 characterized\_definition <=  
 property\_definition.definition  
 property\_definition =>  
 product\_definition\_shape <=  
 shape\_aspect.of\_shape  
 [shape\_aspect <=  
 shape\_aspect\_relationship.relate\_shape\_aspect]  
 [shape\_aspect <=  
 shape\_aspect\_relationship.related\_shape\_aspect]  
 shape\_aspect\_relationship =>  
 dimensional\_location  
 dimensional\_characteristic = dimensional\_location  
 dimensional\_characteristic <=  
 dimensional\_characteristic\_representation.dimension  
 dimensional\_characteristic\_representation  
 dimensional\_characteristic\_representation.representation ->  
 shape\_dimension\_representation <=  
 shape\_representation <=  
 {representation  
 representation.name = 'pipe dimensional shape'}  
 representation  
 representation.items[i] ->  
 {representation\_item  
 representation\_item.name = 'additional length'}

#### **5.1.3.9.2 connection\_commitment\_target**

AIM element: shape\_aspect.description

Source: 41

Reference path: plant\_item\_connection <=  
 shape\_aspect  
 shape\_aspect.description

#### **5.1.3.9.3 connection\_id**

AIM element: shape\_aspect.name

Source: 41

Reference path: plant\_item\_connection <=  
 shape\_aspect  
 shape\_aspect.name

#### **5.1.3.9.4 description**

AIM element: shape\_aspect\_relationship.description

Source: 41

Reference path: plant\_item\_connection <=  
shape\_aspect\_relationship  
shape\_aspect\_relationship.description

### 5.1.3.9.5 shop\_joint

AIM element: group.name

Source: 41

Reference path: plant\_item\_connection  
classification\_item = plant\_item\_connection  
classification\_item <=  
applied\_classification\_assignment.items[i]  
applied\_classification\_assignment <=  
classification\_assignment  
{classification\_assignment.role ->  
classification\_role  
classification\_role.name = 'shop joint type'}  
classification\_assignment.assigned\_classification ->  
group  
group.name

### 5.1.3.9.6 plant\_item\_connection to connection\_inspection\_record

AIM element: PATH

Reference path: plant\_item\_connection <=  
shape\_aspect  
shape\_definition = shape\_aspect  
characterized\_definition = shape\_definition  
characterized\_definition <=  
property\_definition.definition  
property\_definition =>  
{property\_definition.description = 'connection inspection record'}  
material\_property

### 5.1.3.9.7 plant\_item\_connection to connection\_material

AIM element: PATH

Reference path: plant\_item\_connection <=  
shape\_aspect  
shape\_aspect.of\_shape ->  
product\_definition\_shape <=  
property\_definition  
property\_definition.definition ->  
characterized\_definition  
characterized\_definition = characterized\_product\_definition  
characterized\_product\_definition = product\_definition

product\_definition =>  
connection\_material\_definition

### 5.1.3.9.8 **plant\_item\_connection to changed\_plant\_item\_connection**

AIM element: IDENTICAL MAPPING

### 5.1.3.10 **Plant\_item\_connection\_occurrence**

AIM element: plant\_item\_connection

Source: 227

Reference path: plant\_item\_connection <=  
[shape\_aspect\_relationship]  
[shape\_aspect]  
{ shape\_aspect  
shape\_aspect.of\_shape ->  
product\_definition\_shape <=  
property\_definition  
property\_definition.definition ->  
characterized\_definition  
characterized\_definition = characterized\_product\_definition  
characterized\_product\_definition  
characterized\_product\_definition = product\_definition  
product\_definition  
product\_definition.frame\_of\_reference ->  
product\_definition\_context <=  
application\_context\_element  
(application\_context\_element.name = 'functional occurrence')  
(application\_context\_element.name = 'physical occurrence')}

### 5.1.3.10.1 **field\_fit**

AIM element: group.name

Source: 41

Reference path: plant\_item\_connection  
classification\_item = plant\_item\_connection  
classification\_item <-  
applied\_classification\_assignment.items[i]  
applied\_classification\_assignment <=  
classification\_assignment  
{ classification\_assignment.role ->  
classification\_role  
classification\_role.name = 'field fit type'}  
classification\_assignment.assigned\_classification ->  
group  
group.name

### 5.1.3.10.2 **plant\_item\_connection\_occurrence to functional\_connection\_occurrence\_satisfaction (as functional requirements)**

AIM element: PATH

Reference path: plant\_item\_connection <=  
 {shape\_aspect  
 shape\_aspect.of\_shape ->  
 product\_definition\_shape <=  
 property\_definition  
 property\_definition.definition ->  
 characterized\_definition  
 characterized\_definition = characterized\_product\_definition  
 characterized\_product\_definition  
 characterized\_product\_definition = product\_definition  
 product\_definition  
 product\_definition.frame\_of\_reference ->  
 product\_definition\_context <=  
 application\_context\_element  
 application\_context\_element.name = 'functional occurrence'}  
 shape\_aspect <-  
 shape\_aspect\_relationship.relate\_shape\_aspect  
 shape\_aspect\_relationship  
 {shape\_aspect\_relationship  
 shape\_aspect\_relationship.name = 'connection occurrence satisfaction'}

### 5.1.3.10.3 **plant\_item\_connection\_occurrence to functional\_connection\_occurrence\_satisfaction (as requirements satisfaction)**

AIM element: PATH

Reference path: plant\_item\_connection <=  
 {shape\_aspect  
 shape\_aspect.of\_shape ->  
 product\_definition\_shape <=  
 property\_definition  
 property\_definition.definition ->  
 characterized\_definition  
 characterized\_definition = characterized\_product\_definition  
 characterized\_product\_definition  
 characterized\_product\_definition = product\_definition  
 product\_definition  
 product\_definition.frame\_of\_reference ->  
 product\_definition\_context <=  
 application\_context\_element  
 application\_context\_element.name = 'physical occurrence'}  
 shape\_aspect <-  
 shape\_aspect\_relationship.relate\_shape\_aspect  
 shape\_aspect\_relationship  
 {shape\_aspect\_relationship  
 shape\_aspect\_relationship.name = 'connection occurrence satisfaction'}

### 5.1.3.10.4 **plant\_item\_connection\_occurrence to plant\_item\_connector - occurrence**

AIM element: PATH

Reference path: plant\_item\_connection <=  
 shape\_aspect\_relationship  
 [shape\_aspect\_relationship.relate\_shape\_aspect ->]  
 [shape\_aspect\_relationship.related\_shape\_aspect ->]  
 shape\_aspect =>  
 plant\_item\_connector

## 5.1.4 **Connector UoF**

### 5.1.4.1 **Branch hole**

AIM element: plant\_item\_connector

Source: 227

Reference path: plant\_item\_connector <=  
 shape\_aspect  
 {plant\_item\_connector  
 classification\_item = plant\_item\_connector  
 classification\_item <=  
 applied\_classification\_assignment.items[i]  
 applied\_classification\_assignment <=  
 classification\_assignment  
 classification\_assignment.assigned\_classification ->  
 [group =>  
 connector\_end\_type\_class]  
 [group  
 group.name = 'branch hole']}

#### 5.1.4.1.1 **diameter**

#1: The diameter is for the individual connector.

#2: The diameter is for the definition of a family of piping components.

AIM element: [measure\_with\_unit.value\_component]  
 [measure\_with\_unit.unit\_component]

Source: 41

Rules: subtype\_exclusive\_characterized\_object  
 subtype\_mandatory\_shape\_representation

Reference path: plant\_item\_connector <=  
 #1: (shape\_aspect <=  
 dimensional\_size.applies\_to  
 dimensional\_size

```

dimensional_characteristic = dimensional_size
dimensional_characteristic <-
dimensional_characteristic_representation.dimension
dimensional_characteristic_representation
dimensional_characteristic_representation.representation ->
shape_dimension_representation <=
shape_representation <=
{representation
representation.name = 'piping connector dimensional shape'}
representation
representation.items[i] ->
{representation_item
representation_item.name = 'diameter'}}
#2: ({shape_aspect
shape_aspect.of_shape ->
product_definition_shape <=
property_definition
property_definition.definition ->
characterized_definition
characterized_definition = characterized_object
characterized_object =>
piping_component_class}
shape_aspect
shape_definition = shape_aspect
shape_definition
characterized_definition = shape_definition
characterized_definition <-
property_definition.definition
property_definition
represented_definition = property_definition
represented_definition <-
property_definition_representation.definition
property_definition_representation
property_definition_representation.used_representation ->
representation
(representation.items[i] ->
{representation_item
(representation_item.name = 'maximum diameter')
(representation_item.name = 'minimum diameter'}})
([representation.items[i] ->
{representation_item
representation_item.name = 'maximum diameter'}}]
[representation.items[i] ->
{representation_item
representation_item.name = 'minimum diameter'}}]))
representation_item =>
measure_representation_item <=
{measure_with_unit =>
length_measure_with_unit}
measure_with_unit
[measure_with_unit.value_component]
[measure_with_unit.unit_component]

```

### 5.1.4.2 Buttweld

AIM element: plant\_item\_connector

Source: 227

Reference path: plant\_item\_connector <=  
 shape\_aspect  
 {plant\_item\_connector  
 classification\_item = plant\_item\_connector  
 classification\_item <=  
 applied\_classification\_assignment.items[i]  
 applied\_classification\_assignment <=  
 classification\_assignment  
 classification\_assignment.assigned\_classification ->  
 [group =>  
 piping\_connector\_class]  
 [group  
 group.name = 'buttweld']}

#### 5.1.4.2.1 root\_gap

AIM element: [measure\_with\_unit.value\_component]  
 [measure\_with\_unit.unit\_component]

Source: 41

Rules: subtype\_mandatory\_shape\_representation

Reference path: plant\_item\_connector <=  
 shape\_aspect <=  
 [shape\_aspect\_relationship.relate\_shape\_aspect  
 {shape\_aspect\_relationship  
 shape\_aspect\_relationship.name = 'connector dimensional aspect'}  
 shape\_aspect\_relationship  
 shape\_aspect\_relationship.related\_shape\_aspect ->  
 shape\_aspect <=  
 shape\_aspect\_relationship.relate\_shape\_aspect]  
 [shape\_aspect\_relationship.relate\_shape\_aspect  
 {shape\_aspect\_relationship  
 shape\_aspect\_relationship.name = 'connector dimensional aspect'}  
 shape\_aspect\_relationship  
 shape\_aspect\_relationship.related\_shape\_aspect ->  
 shape\_aspect <=  
 shape\_aspect\_relationship.related\_shape\_aspect]  
 shape\_aspect\_relationship =>  
 dimensional\_location  
 dimensional\_characteristic = dimensional\_location  
 dimensional\_characteristic <=  
 dimensional\_characteristic\_representation.dimension  
 dimensional\_characteristic\_representation  
 dimensional\_characteristic\_representation.representation ->

```

shape_dimension_representation <=
shape_representation <=
{representation
representation.name = 'piping connector dimensional shape'}
representation
representation.items[i] ->
{representation_item
representation_item.name = 'root gap'}
representation_item =>
measure_representation_item <=
{measure_with_unit =>
length_measure_with_unit}
measure_with_unit
[measure_with_unit.value_component]
[measure_with_unit.unit_component]

```

### 5.1.4.3 Catalogue\_connector

AIM element: catalogue\_connector

Source: 227

Reference path: catalogue\_connector <=

```

[externally_defined_item]
[shape_aspect
{shape_aspect
shape_aspect.of_shape ->
product_definition_shape <=
property_definition
property_definition.definition ->
characterized_definition
characterized_definition = characterized_object
characterized_object}]

```

#### 5.1.4.3.1 catalogue\_connector to connector\_definition (is defined by)

AIM element: PATH

Reference path: catalogue\_connector <=

```

shape_aspect <-
shape_aspect_relationship.related_shape_aspect
{shape_aspect_relationship
shape_aspect_relationship.name = 'definition usage'}
shape_aspect_relationship
shape_aspect_relationship.relate_shape_aspect ->
shape_aspect =>
plant_item_connector

```

### 5.1.4.4 Clamped

AIM element: plant\_item\_connector

Source: 227

Reference path: plant\_item\_connector <=  
 shape\_aspect  
 {plant\_item\_connector  
 classification\_item = plant\_item\_connector  
 classification\_item <=  
 applied\_classification\_assignment.items[i]  
 applied\_classification\_assignment <=  
 classification\_assignment  
 classification\_assignment.assigned\_classification ->  
 [group =>  
 piping\_connector\_class]  
 [group  
 group.name = 'clamped']}

### 5.1.4.5 Connector\_definition

AIM element: plant\_item\_connector

Source: 227

Reference path: plant\_item\_connector <=  
 shape\_aspect  
 {shape\_aspect  
 shape\_aspect.of\_shape ->  
 product\_definition\_shape <=  
 property\_definition  
 property\_definition.definition ->  
 characterized\_definition  
 characterized\_definition = characterized\_product\_definition  
 characterized\_product\_definition  
 characterized\_product\_definition = product\_definition  
 product\_definition  
 product\_definition.frame\_of\_reference ->  
 product\_definition\_context <=  
 application\_context\_element  
 (application\_context\_element.name = 'functional definition')  
 (application\_context\_element.name = 'physical definition')}

#### 5.1.4.5.1 connector\_definition to catalogue\_connector (is defined as)

AIM element: PATH

Reference path: plant\_item\_connector <=  
 shape\_aspect <=  
 shape\_aspect\_relationship.related\_shape\_aspect  
 {shape\_aspect\_relationship  
 shape\_aspect\_relationship.name = 'catalogue usage'}  
 shape\_aspect\_relationship  
 shape\_aspect\_relationship.relate\_shape\_aspect ->  
 shape\_aspect =>

catalogue\_connector

#### 5.1.4.5.2 connector\_definition to functional\_connector\_definition - satisfaction (as functional requirements for)

AIM element: PATH

Reference path: plant\_item\_connector <=  
 shape\_aspect  
 {shape\_aspect  
 shape\_aspect.of\_shape ->  
 product\_definition\_shape <=  
 property\_definition  
 property\_definition.definition ->  
 characterized\_definition  
 characterized\_definition = characterized\_product\_definition  
 characterized\_product\_definition  
 characterized\_product\_definition = product\_definition  
 product\_definition  
 product\_definition.frame\_of\_reference ->  
 product\_definition\_context <=  
 application\_context\_element  
 application\_context\_element.name = 'functional definition'}  
 shape\_aspect <-  
 shape\_aspect\_relationship.relate\_shape\_aspect  
 shape\_aspect\_relationship  
 {shape\_aspect\_relationship  
 shape\_aspect\_relationship.name = 'connector definition satisfaction'}

#### 5.1.4.5.3 connector\_definition to functional\_connector\_definition - satisfaction (as satisfies requirements for)

AIM element: PATH

Reference path: plant\_item\_connector <=  
 {shape\_aspect  
 shape\_aspect.of\_shape ->  
 product\_definition\_shape <=  
 property\_definition  
 property\_definition.definition ->  
 characterized\_definition  
 characterized\_definition = characterized\_product\_definition  
 characterized\_product\_definition  
 characterized\_product\_definition = product\_definition  
 product\_definition  
 product\_definition.frame\_of\_reference ->  
 product\_definition\_context <=  
 application\_context\_element  
 application\_context\_element.name = 'physical definition'}  
 shape\_aspect <-  
 shape\_aspect\_relationship.relate\_shape\_aspect  
 shape\_aspect\_relationship

```
{shape_aspect_relationship
shape_aspect_relationship.name = 'connector definition satisfaction'}
```

#### 5.1.4.5.4 connector\_definition to plant\_item\_connector\_occurrence

AIM element: PATH

Rules: application\_context\_requires\_ap\_definition  
dependent\_instantiable\_application\_context  
dependent\_instantiable\_product\_definition\_context  
product\_definition\_context\_name\_constraint

Reference path: plant\_item\_connector <=  
shape\_aspect <=  
shape\_aspect\_relationship.relate\_shape\_aspect  
{shape\_aspect\_relationship  
shape\_aspect\_relationship.name = 'usage'}  
shape\_aspect\_relationship  
shape\_aspect\_relationship.related\_shape\_aspect ->  
{shape\_aspect  
shape\_aspect.of\_shape ->  
product\_definition\_shape <=  
property\_definition  
property\_definition.definition ->  
characterized\_definition  
characterized\_definition = characterized\_product\_definition  
characterized\_product\_definition  
characterized\_product\_definition = product\_definition  
product\_definition  
product\_definition.frame\_of\_reference ->  
product\_definition\_context <=  
application\_context\_element  
(application\_context\_element.name = 'functional occurrence')  
(application\_context\_element.name = 'physical occurrence')}  
shape\_aspect =>  
plant\_item\_connector

#### 5.1.4.6 Cross\_section\_flat\_oval

AIM element: hvac\_cross\_section

Source: 227

Reference path: hvac\_cross\_section <=  
shape\_aspect  
{shape\_aspect.description = 'flat oval'}

##### 5.1.4.6.1 height

AIM element: [measure\_with\_unit.value\_component]  
[measure\_with\_unit.unit\_component]

Source: 41

Rules: subtype\_mandatory\_shape\_representation

Reference path: hvac\_cross\_section <=  
 shape\_aspect <-  
 [shape\_aspect\_relationship.relying\_shape\_aspect  
 {shape\_aspect\_relationship  
 shape\_aspect\_relationship.name = 'cross section dimensional aspect'}  
 shape\_aspect\_relationship  
 shape\_aspect\_relationship.related\_shape\_aspect ->  
 shape\_aspect <-  
 shape\_aspect\_relationship.relying\_shape\_aspect]  
 [shape\_aspect\_relationship.relying\_shape\_aspect  
 {shape\_aspect\_relationship  
 shape\_aspect\_relationship.name = 'cross section dimensional aspect'}  
 shape\_aspect\_relationship  
 shape\_aspect\_relationship.related\_shape\_aspect ->  
 shape\_aspect <-  
 shape\_aspect\_relationship.related\_shape\_aspect]  
 shape\_aspect\_relationship =>  
 dimensional\_location  
 dimensional\_characteristic = dimensional\_location  
 dimensional\_characteristic <-  
 dimensional\_characteristic\_representation.dimension  
 dimensional\_characteristic\_representation  
 dimensional\_characteristic\_representation.representation ->  
 shape\_dimension\_representation <=  
 shape\_representation <=  
 {representation  
 representation.name = 'hvac connector dimensional shape'}  
 representation  
 representation.items[i] ->  
 {representation\_item  
 representation\_item.name = 'height'}  
 representation\_item =>  
 measure\_representation\_item <=  
 {measure\_with\_unit =>  
 length\_measure\_with\_unit}  
 measure\_with\_unit  
 [measure\_with\_unit.value\_component]  
 [measure\_with\_unit.unit\_component]

#### 5.1.4.6.2 width

AIM element: [measure\_with\_unit.value\_component]  
 [measure\_with\_unit.unit\_component]

Source: 41

Reference path: hvac\_cross\_section <=  
 shape\_aspect <-  
 [shape\_aspect\_relationship.relying\_shape\_aspect  
 {shape\_aspect\_relationship

```

shape_aspect_relationship.name = 'cross section dimensional aspect'}
shape_aspect_relationship
shape_aspect_relationship.related_shape_aspect ->
shape_aspect <-
shape_aspect_relationship.relate_shape_aspect]
[shape_aspect_relationship.relate_shape_aspect
{shape_aspect_relationship
shape_aspect_relationship.name = 'cross section dimensional aspect'}
shape_aspect_relationship
shape_aspect_relationship.related_shape_aspect ->
shape_aspect <-
shape_aspect_relationship.related_shape_aspect]
shape_aspect_relationship =>
dimensional_location
dimensional_characteristic = dimensional_location
dimensional_characteristic <-
dimensional_characteristic_representation.dimension
dimensional_characteristic_representation
dimensional_characteristic_representation.representation ->
shape_dimension_representation <=
shape_representation <=
{representation
representation.name = 'hvac connector dimensional shape'}
representation
representation.items[i] ->
{representation_item
representation_item.name = 'width'}
representation_item =>
measure_representation_item <=
{measure_with_unit =>
length_measure_with_unit}
measure_with_unit
[measure_with_unit.value_component]
[measure_with_unit.unit_component]

```

#### 5.1.4.7 Cross\_section\_non\_standard

AIM element: hvac\_cross\_section

Source: 227

Reference path: hvac\_cross\_section <=
   
shape\_aspect
   
{shape\_aspect.description = 'non standard'}

##### 5.1.4.7.1 closed\_bounded\_curve

AIM element: curve

Source: 42

Reference path: hvac\_cross\_section <=
   
shape\_aspect

```

shape_definition = shape_aspect
shape_definition
characterized_definition = shape_definition
characterized_definition <-
property_definition.definition
property_definition
represented_definition = property_definition
represented_definition <-
property_definition_representation.definition
property_definition_representation
property_definition_representation.used_representation ->
representation
{representation.name = 'cross section representation'}
representation.items[i] ->
representation_item
{representation_item.name = 'closed bounded curve'}
representation_item =>
geometric_representation_item =>
curve

```

#### 5.1.4.8 Cross\_section\_radiused\_corner

AIM element: hvac\_cross\_section

Source: 227

Reference path: hvac\_cross\_section <=  
 shape\_aspect  
 {shape\_aspect.description = 'radiused corner'}

##### 5.1.4.8.1 height

AIM element: [measure\_with\_unit.value\_component]  
 [measure\_with\_unit.unit\_component]

Source: 41

Rules: subtype\_mandatory\_shape\_representation

Reference path: hvac\_cross\_section <=  
 shape\_aspect <-  
 [shape\_aspect\_relationship.relate\_shape\_aspect  
 {shape\_aspect\_relationship  
 shape\_aspect\_relationship.name = 'cross section dimensional aspect'}  
 shape\_aspect\_relationship  
 shape\_aspect\_relationship.related\_shape\_aspect ->  
 shape\_aspect <-  
 shape\_aspect\_relationship.relate\_shape\_aspect]  
 [shape\_aspect\_relationship.relate\_shape\_aspect  
 {shape\_aspect\_relationship  
 shape\_aspect\_relationship.name = 'cross section dimensional aspect'}  
 shape\_aspect\_relationship  
 shape\_aspect\_relationship.related\_shape\_aspect ->

```

shape_aspect <-
shape_aspect_relationship.related_shape_aspect]
shape_aspect_relationship =>
dimensional_location
dimensional_characteristic = dimensional_location
dimensional_characteristic <-
dimensional_characteristic_representation.dimension
dimensional_characteristic_representation
dimensional_characteristic_representation.representation ->
shape_dimension_representation <=
shape_representation <=
{representation
representation.name = 'hvac connector dimensional shape'}
representation
representation.items[i] ->
{representation_item
representation_item.name = 'height'}
representation_item =>
measure_representation_item <=
{measure_with_unit =>
length_measure_with_unit}
measure_with_unit
[measure_with_unit.value_component]
[measure_with_unit.unit_component]

```

#### 5.1.4.8.2 width

AIM element: [measure\_with\_unit.value\_component]  
[measure\_with\_unit.unit\_component]

Source: 41

Rules: subtype\_mandatory\_shape\_representation

Reference path: hvac\_cross\_section <=

```

shape_aspect <-
[shape_aspect_relationship.relate_shape_aspect
{shape_aspect_relationship
shape_aspect_relationship.name = 'cross section dimensional aspect'}
shape_aspect_relationship
shape_aspect_relationship.related_shape_aspect ->
shape_aspect <-
shape_aspect_relationship.relate_shape_aspect]
[shape_aspect_relationship.relate_shape_aspect
{shape_aspect_relationship
shape_aspect_relationship.name = 'cross section dimensional aspect'}
shape_aspect_relationship
shape_aspect_relationship.related_shape_aspect ->
shape_aspect <-
shape_aspect_relationship.related_shape_aspect]
shape_aspect_relationship =>
dimensional_location
dimensional_characteristic = dimensional_location
dimensional_characteristic <-

```

```

dimensional_characteristic_representation.dimension
dimensional_characteristic_representation
dimensional_characteristic_representation.representation ->
shape_dimension_representation <=
shape_representation <=
{representation
representation.name = 'hvac connector dimensional shape'}
representation
representation.items[i] ->
{representation_item
representation_item.name = 'width'}
representation_item =>
measure_representation_item <=
{measure_with_unit =>
length_measure_with_unit}
measure_with_unit
[measure_with_unit.value_component]
[measure_with_unit.unit_component]

```

### 5.1.4.8.3 corner\_radius

AIM element: [measure\_with\_unit.value\_component]  
[measure\_with\_unit.unit\_component]

Source: 41

Rules: subtype\_mandatory\_shape\_representation

Reference path: hvac\_cross\_section <=

```

shape_aspect <-
[shape_aspect_relationship.relate_shape_aspect
{shape_aspect_relationship
shape_aspect_relationship.name = 'cross section dimensional aspect'}
shape_aspect_relationship
shape_aspect_relationship.related_shape_aspect ->
shape_aspect <-
shape_aspect_relationship.relate_shape_aspect]
[shape_aspect_relationship.relate_shape_aspect
{shape_aspect_relationship
shape_aspect_relationship.name = 'cross section dimensional aspect'}
shape_aspect_relationship
shape_aspect_relationship.related_shape_aspect ->
shape_aspect <-
shape_aspect_relationship.related_shape_aspect]
shape_aspect_relationship =>
dimensional_location
dimensional_characteristic = dimensional_location
dimensional_characteristic <-
dimensional_characteristic_representation.dimension
dimensional_characteristic_representation
dimensional_characteristic_representation.representation ->
shape_dimension_representation <=
shape_representation <=
{representation

```

```

representation.name = 'hvac connector dimensional shape'}
representation
representation.items[i] ->
{representation_item
representation_item.name = 'corner radius'}
representation_item =>
measure_representation_item <=
{measure_with_unit =>
length_measure_with_unit}
measure_with_unit
[measure_with_unit.value_component]
[measure_with_unit.unit_component]

```

#### 5.1.4.9 Cross\_section\_rectangular

AIM element: hvac\_cross\_section

Source: 227

Reference path: hvac\_cross\_section <=
 shape\_aspect
 {shape\_aspect.description = 'rectangular'}

##### 5.1.4.9.1 height

AIM element: [measure\_with\_unit.value\_component]
 [measure\_with\_unit.unit\_component]

Source: 41

Rules: subtype\_mandatory\_shape\_representation

Reference path: hvac\_cross\_section <=
 shape\_aspect <-
 [shape\_aspect\_relationship.relate\_shape\_aspect
 {shape\_aspect\_relationship
 shape\_aspect\_relationship.name = 'cross section dimensional aspect'}
 shape\_aspect\_relationship
 shape\_aspect\_relationship.related\_shape\_aspect ->
 shape\_aspect <-
 shape\_aspect\_relationship.relate\_shape\_aspect]
 [shape\_aspect\_relationship.relate\_shape\_aspect
 {shape\_aspect\_relationship
 shape\_aspect\_relationship.name = 'cross section dimensional aspect'}
 shape\_aspect\_relationship
 shape\_aspect\_relationship.related\_shape\_aspect ->
 shape\_aspect <-
 shape\_aspect\_relationship.related\_shape\_aspect]
 shape\_aspect\_relationship =>
 dimensional\_location
 dimensional\_characteristic = dimensional\_location
 dimensional\_characteristic <-
 dimensional\_characteristic\_representation.dimension

```

dimensional_characteristic_representation
dimensional_characteristic_representation.representation ->
shape_dimension_representation <=
shape_representation <=
{representation
representation.name = 'hvac connector dimensional shape'}
representation
representation.items[i] ->
{representation_item
representation_item.name = 'height'}
representation_item =>
measure_representation_item <=
{measure_with_unit =>
length_measure_with_unit}
measure_with_unit
[measure_with_unit.value_component]
[measure_with_unit.unit_component]

```

#### 5.1.4.9.2 width

AIM element: [measure\_with\_unit.value\_component]  
[measure\_with\_unit.unit\_component]

Source: 41

Rules: subtype\_mandatory\_shape\_representation

Reference path: hvac\_cross\_section <=

```

shape_aspect <-
[shape_aspect_relationship.relate_shape_aspect
{shape_aspect_relationship
shape_aspect_relationship.name = 'cross section dimensional aspect'}
shape_aspect_relationship
shape_aspect_relationship.related_shape_aspect ->
shape_aspect <-
shape_aspect_relationship.relate_shape_aspect]
[shape_aspect_relationship.relate_shape_aspect
{shape_aspect_relationship
shape_aspect_relationship.name = 'cross section dimensional aspect'}
shape_aspect_relationship
shape_aspect_relationship.related_shape_aspect ->
shape_aspect <-
shape_aspect_relationship.related_shape_aspect]
shape_aspect_relationship =>
dimensional_location
dimensional_characteristic = dimensional_location
dimensional_characteristic <-
dimensional_characteristic_representation.dimension
dimensional_characteristic_representation
dimensional_characteristic_representation.representation ->
shape_dimension_representation <=
shape_representation <=
{representation
representation.name = 'hvac connector dimensional shape'}

```

```

representation
representation.items[i] ->
{representation_item
representation_item.name = 'width'}
representation_item =>
measure_representation_item <=
{measure_with_unit =>
length_measure_with_unit}
measure_with_unit
[measure_with_unit.value_component]
[measure_with_unit.unit_component]

```

#### 5.1.4.10 Cross\_section\_round

AIM element: hvac\_cross\_section

Source: 227

Reference path: hvac\_cross\_section <=
 shape\_aspect
 {shape\_aspect.description = 'round'}

##### 5.1.4.10.1 radius

AIM element: [measure\_with\_unit.value\_component]
 [measure\_with\_unit.unit\_component]

Source: 41

Rules: subtype\_mandatory\_shape\_representation

Reference path: hvac\_cross\_section <=
 shape\_aspect <-
 [shape\_aspect\_relationship.relating\_shape\_aspect
 {shape\_aspect\_relationship
 shape\_aspect\_relationship.name = 'cross section dimensional aspect'}
 shape\_aspect\_relationship
 shape\_aspect\_relationship.related\_shape\_aspect ->
 shape\_aspect <-
 shape\_aspect\_relationship.relating\_shape\_aspect]
 [shape\_aspect\_relationship.relating\_shape\_aspect
 {shape\_aspect\_relationship
 shape\_aspect\_relationship.name = 'cross section dimensional aspect'}
 shape\_aspect\_relationship
 shape\_aspect\_relationship.related\_shape\_aspect ->
 shape\_aspect <-
 shape\_aspect\_relationship.related\_shape\_aspect]
 shape\_aspect\_relationship =>
 dimensional\_location
 dimensional\_characteristic = dimensional\_location
 dimensional\_characteristic <-
 dimensional\_characteristic\_representation.dimension
 dimensional\_characteristic\_representation

```

dimensional_characteristic_representation.representation ->
shape_dimension_representation <=
shape_representation <=
{representation
representation.name = 'hvac connector dimensional shape'}
representation
representation.items[i] ->
{representation_item
representation_item.name = 'radius'}
representation_item =>
measure_representation_item <=
{measure_with_unit =>
length_measure_with_unit}
measure_with_unit
[measure_with_unit.value_component]
[measure_with_unit.unit_component]

```

#### 5.1.4.11 Cross\_section\_triangular

AIM element: hvac\_cross\_section

Source: 227

Reference path: hvac\_cross\_section <=
  
shape\_aspect
  
{shape\_aspect.description = 'triangular'}

##### 5.1.4.11.1 vertex\_1

AIM element: cartesian\_point

Source: 42

Reference path: hvac\_cross\_section <=
  
shape\_aspect
  
shape\_definition = shape\_aspect
  
shape\_definition
  
characterized\_definition = shape\_definition
  
characterized\_definition <-
  
property\_definition.definition
  
property\_definition
  
represented\_definition = property\_definition
  
represented\_definition <-
  
property\_definition\_representation.definition
  
property\_definition\_representation
  
property\_definition\_representation.used\_representation ->
  
representation
  
{representation.name = 'cross section representation'}
  
representation.items[i] ->
  
representation\_item
  
{representation\_item.name = 'vertex 1'}
  
representation\_item =>
  
geometric\_representation\_item =>

```
point =>
cartesian_point
```

### 5.1.4.11.2 vertex\_2

AIM element: cartesian\_point

Source: 42

Reference path: hvac\_cross\_section <=  
 shape\_aspect  
 shape\_definition = shape\_aspect  
 shape\_definition  
 characterized\_definition = shape\_definition  
 characterized\_definition <=  
 property\_definition.definition  
 property\_definition  
 represented\_definition = property\_definition  
 represented\_definition <=  
 property\_definition\_representation.definition  
 property\_definition\_representation  
 property\_definition\_representation.used\_representation ->  
 representation  
 {representation.name = 'cross section representation'}  
 representation.items[i] ->  
 representation\_item  
 {representation\_item.name = 'vertex 2'}  
 representation\_item =>  
 geometric\_representation\_item =>  
 point =>  
 cartesian\_point

### 5.1.4.11.3 vertex\_3

AIM element: cartesian\_point

Source: 42

Reference path: hvac\_cross\_section <=  
 shape\_aspect  
 shape\_definition = shape\_aspect  
 shape\_definition  
 characterized\_definition = shape\_definition  
 characterized\_definition <=  
 property\_definition.definition  
 property\_definition  
 represented\_definition = property\_definition  
 represented\_definition <=  
 property\_definition\_representation.definition  
 property\_definition\_representation  
 property\_definition\_representation.used\_representation ->  
 representation  
 {representation.name = 'cross section representation'}

```

representation.items[i] ->
representation_item
{representation_item.name = 'vertex 1'}
representation_item =>
geometric_representation_item =>
point =>
cartesian_point

```

#### 5.1.4.12 Electrical\_connector

AIM element: plant\_item\_connector

Source: 227

Reference path: plant\_item\_connector <=  
 shape\_aspect  
 {plant\_item\_connector  
 classification\_item = plant\_item\_connector  
 classification\_item <=  
 applied\_classification\_assignment.items[i]  
 applied\_classification\_assignment <=  
 classification\_assignment  
 classification\_assignment.assigned\_classification ->  
 group =>  
 electrical\_connector\_class}

##### 5.1.4.12.1 type

AIM element: group.name

Source: 41

Reference path: plant\_item\_connector  
 classification\_item = plant\_item\_connector  
 classification\_item <=  
 applied\_classification\_assignment.items[i]  
 applied\_classification\_assignment <=  
 {classification\_assignment  
 classification\_assignment.role ->  
 classification\_role  
 classification\_role.name = 'electrical connector type classification'}  
 classification\_assignment  
 classification\_assignment.assigned\_classification ->  
 {group =>  
 electrical\_connector\_class}  
 group  
 group.name

#### 5.1.4.13 Female\_end

AIM element: plant\_item\_connector

Source: 227

Reference path: 

```
plant_item_connector <=
shape_aspect
{plant_item_connector
classification_item = plant_item_connector
classification_item <-
applied_classification_assignment.items[i]
applied_classification_assignment <=
classification_assignment
classification_assignment.assigned_group ->
[group =>
connector_end_type_class]
[group
group.name = 'female end']}
```

### 5.1.4.13.1 depth

#1: The depth is for the individual connector.

#2: The depth is for the definition of a family of piping components.

AIM element: 

```
[measure_with_unit.value_component]
[measure_with_unit.unit_component]
```

Source: 41

Rules: 

```
subtype_exclusive_characterized_object
subtype_mandatory_shape_representation
```

Reference path: 

```
plant_item_connector <=
#1: (shape_aspect <-
[shape_aspect_relationship.relate_shape_aspect
{shape_aspect_relationship
shape_aspect_relationship.name = 'connector dimensional aspect'}
shape_aspect_relationship
shape_aspect_relationship.related_shape_aspect ->
shape_aspect <-
shape_aspect_relationship.relate_shape_aspect]
[shape_aspect_relationship.relate_shape_aspect
{shape_aspect_relationship
shape_aspect_relationship.name = 'connector dimensional aspect'}
shape_aspect_relationship
shape_aspect_relationship.related_shape_aspect ->
shape_aspect <-
shape_aspect_relationship.related_shape_aspect]
shape_aspect_relationship =>
dimensional_location
dimensional_characteristic = dimensional_location
dimensional_characteristic <-
dimensional_characteristic_representation.dimension
dimensional_characteristic_representation
dimensional_characteristic_representation.representation ->
shape_dimension_representation <=
```

```

shape_representation <=
{representation
representation.name = 'piping connector dimensional shape'}
representation
representation.items[i] ->
{representation_item
representation_item.name = 'depth'})

#2: ({shape_aspect
shape_aspect.of_shape ->
product_definition_shape <=
property_definition
property_definition.definition ->
characterized_definition
characterized_definition = characterized_object
characterized_object =>
piping_component_class}
shape_aspect
shape_definition = shape_aspect
shape_definition
characterized_definition = shape_definition
characterized_definition <-
property_definition.definition
property_definition
represented_definition = property_definition
represented_definition <-
property_definition_representation.definition
property_definition_representation
property_definition_representation.used_representation ->
{representation
representation.name = 'piping connector class dimension'}
representation
(representation.items[i] ->
{representation_item
(representation_item.name = 'maximum depth')
(representation_item.name = 'minimum depth')})
([representation.items[i] ->
{representation_item
representation_item.name = 'maximum depth'}]
[representation.items[i] ->
{representation_item
representation_item.name = 'minimum depth'}]))
representation_item =>
measure_representation_item <=
{measure_with_unit =>
length_measure_with_unit}
measure_with_unit
[measure_with_unit.value_component]
[measure_with_unit.unit_component]

```

#### 5.1.4.13.2 hub\_inside\_diameter

#1: The diameter is for the individual connector.

#2: The diameter is for the definition of a family of piping components.

AIM element: [measure\_with\_unit.value\_component]  
[measure\_with\_unit.unit\_component]

Source: 41

Rules: subtype\_exclusive\_characterized\_object  
subtype\_mandatory\_shape\_representation

Reference path: plant\_item\_connector <=  
#1: (shape\_aspect <-  
dimensional\_size.applies\_to  
dimensional\_size  
dimensional\_characteristic = dimensional\_size  
dimensional\_characteristic <-  
dimensional\_characteristic\_representation.dimension  
dimensional\_characteristic\_representation  
dimensional\_characteristic\_representation.representation ->  
shape\_dimension\_representation <=  
shape\_representation <=  
{representation  
representation.name = 'piping connector dimensional shape'}  
representation  
representation.items[i] ->  
{representation\_item  
representation\_item.name = 'hub inside diameter'}})

#2: ({shape\_aspect  
shape\_aspect.of\_shape ->  
product\_definition\_shape <=  
property\_definition  
property\_definition.definition ->  
characterized\_definition  
characterized\_definition = characterized\_object  
characterized\_object =>  
piping\_component\_class}  
shape\_aspect  
shape\_definition = shape\_aspect  
shape\_definition  
characterized\_definition = shape\_definition  
characterized\_definition <-  
property\_definition.definition  
property\_definition  
represented\_definition = property\_definition  
represented\_definition <-  
property\_definition\_representation.definition  
property\_definition\_representation  
property\_definition\_representation.used\_representation ->  
{representation  
representation.name = 'piping connector class dimension'}  
representation

```

(representation.items[i] ->
{representation_item
(representation_item.name = 'maximum hub inside diameter')
(representation_item.name = 'minimum hub inside diameter'))}
([representation.items[i] ->
{representation_item
representation_item.name = 'maximum hub inside diameter'}}]
[representation.items[i] ->
{representation_item
representation_item.name = 'minimum hub inside diameter'}}])
representation_item =>
measure_representation_item <=
{measure_with_unit =>
length_measure_with_unit}
measure_with_unit
[measure_with_unit.value_component]
[measure_with_unit.unit_component]

```

### 5.1.4.13.3 hub\_length

#1: The length is for the individual connector.

#2: The length is for the definition of a family of piping components.

AIM element: [measure\_with\_unit.value\_component]  
[measure\_with\_unit.unit\_component]

Source: 41

Rules: subtype\_exclusive\_characterized\_object  
subtype\_mandatory\_shape\_representation

Reference path: plant\_item\_connector <=

```

#1: (shape_aspect <-
dimensional_size.applies_to
dimensional_size
dimensional_characteristic = dimensional_size
dimensional_characteristic <-
dimensional_characteristic_representation.dimension
dimensional_characteristic_representation
dimensional_characteristic_representation.representation ->
shape_dimension_representation <=
shape_representation <=
{representation
representation.name = 'piping connector dimensional shape'}
representation
representation.items[i] ->
{representation_item
representation_item.name = 'hub length'})

#2: ({shape_aspect
shape_aspect.of_shape ->
product_definition_shape <=
property_definition

```

```

property_definition.definition ->
characterized_definition
characterized_definition = characterized_object
characterized_object =>
  piping_component_class}
shape_aspect
shape_definition = shape_aspect
shape_definition
characterized_definition = shape_definition
characterized_definition <-
  property_definition.definition
  property_definition
  represented_definition = property_definition
  represented_definition <-
    property_definition_representation.definition
    property_definition_representation
    property_definition_representation.used_representation ->
    {representation
     representation.name = 'piping connector class dimension'}
    representation
    (representation.items[i] ->
     {representation_item
      (representation_item.name = 'maximum hub length')
      (representation_item.name = 'minimum hub length'}})
    ([representation.items[i] ->
     {representation_item
      representation_item.name = 'maximum hub length'}]
     [representation.items[i] ->
     {representation_item
      representation_item.name = 'minimum hub length'}}]))
    representation_item =>
    measure_representation_item <=
    {measure_with_unit =>
     length_measure_with_unit}
    measure_with_unit
    [measure_with_unit.value_component]
    [measure_with_unit.unit_component]

```

#### 5.1.4.13.4 hub\_outside\_diameter

#1: The diameter is for the individual connector.

#2: The diameter is for the definition of a family of piping components.

AIM element:      [measure\_with\_unit.value\_component]  
                      [measure\_with\_unit.unit\_component]

Source:            41

Rules:             subtype\_exclusive\_characterized\_object  
                      subtype\_mandatory\_shape\_representation

Reference path:    plant\_item\_connector <=

```

#1: (shape_aspect <-
dimensional_size.applies_to
dimensional_size
dimensional_characteristic = dimensional_size
dimensional_characteristic <-
dimensional_characteristic_representation.dimension
dimensional_characteristic_representation
dimensional_characteristic_representation.representation ->
shape_dimension_representation <=
shape_representation <=
{representation
representation.name = 'piping connector dimensional shape'}
representation
representation.items[i] ->
{representation_item
representation_item.name = 'hub outside diameter'})

#2: ({shape_aspect
shape_aspect.of_shape ->
product_definition_shape <=
property_definition
property_definition.definition ->
characterized_definition
characterized_definition = characterized_object
characterized_object =>
piping_component_class}
shape_aspect
shape_definition = shape_aspect
shape_definition
characterized_definition = shape_definition
characterized_definition <-
property_definition.definition
property_definition
represented_definition = property_definition
represented_definition <-
property_definition_representation.definition
property_definition_representation
property_definition_representation.used_representation ->
{representation
representation.name = 'piping connector class dimension'}
representation
(representation.items[i] ->
{representation_item
(representation_item.name = 'maximum hub outside diameter')
(representation_item.name = 'minimum hub outside diameter')})
([representation.items[i] ->
{representation_item
representation_item.name = 'maximum hub outside diameter'}]
[representation.items[i] ->
{representation_item
representation_item.name = 'minimum hub outside diameter'}}])
representation_item =>
measure_representation_item <=
{measure_with_unit =>

```

```
length_measure_with_unit}
measure_with_unit
[measure_with_unit.value_component]
[measure_with_unit.unit_component]
```

#### 5.1.4.14 Flanged

AIM element: plant\_item\_connector

Source: 227

Reference path: plant\_item\_connector <=  
 shape\_aspect  
 {plant\_item\_connector  
 classification\_item = plant\_item\_connector  
 classification\_item <=  
 applied\_classification\_assignment.items[i]  
 applied\_classification\_assignment <=  
 classification\_assignment  
 classification\_assignment.assigned\_classification ->  
 [group =>  
 piping\_connector\_class]  
 [group  
 group.name = 'flanged']}

#### 5.1.4.15 Flanged\_end

AIM element: plant\_item\_connector

Source: 227

Reference path: plant\_item\_connector <=  
 shape\_aspect  
 {plant\_item\_connector  
 classification\_item = plant\_item\_connector  
 classification\_item <=  
 applied\_classification\_assignment.items[i]  
 applied\_classification\_assignment <=  
 classification\_assignment  
 classification\_assignment.assigned\_classification ->  
 [group =>  
 connector\_end\_type\_class]  
 [group  
 group.name = 'flanged end']}

#### 5.1.4.15.1 face\_finish

AIM element: descriptive\_representation\_item.description

Source: 45

Reference path: plant\_item\_connector <=  
 shape\_aspect

```

shape_definition = shape_aspect
shape_definition
characterized_definition = shape_definition
characterized_definition <-
property_definition.definition
property_definition
represented_definition = property_definition
represented_definition <-
property_definition_representation.definition
property_definition_representation
property_definition_representation.used_representation ->
representation
representation.items[i] ->
{representation_item
representation_item.name = 'face finish'}
representation_item =>
descriptive_representation_item
descriptive_representation_item.description

```

### 5.1.4.15.2 flange\_inside\_diameter

#1: The diameter is for the individual connector.

#2: The diameter is for the definition of a family of piping components.

AIM element: [measure\_with\_unit.value\_component]  
[measure\_with\_unit.unit\_component]

Source: 41

Rules: subtype\_exclusive\_characterized\_object  
subtype\_mandatory\_shape\_representation

Reference path: plant\_item\_connector <=  
#1: (shape\_aspect <-  
dimensional\_size.applies\_to  
dimensional\_size  
dimensional\_characteristic = dimensional\_size  
dimensional\_characteristic <-  
dimensional\_characteristic\_representation.dimension  
dimensional\_characteristic\_representation  
dimensional\_characteristic\_representation.representation ->  
shape\_dimension\_representation <=  
shape\_representation <=  
{representation  
representation.name = 'piping connector dimensional shape'}  
representation  
representation.items[i] ->  
{representation\_item  
representation\_item.name = 'flange inside diameter'})  
#2: ({shape\_aspect  
shape\_aspect.of\_shape ->  
product\_definition\_shape <=  
property\_definition

```

property_definition.definition ->
characterized_definition
characterized_definition = characterized_object
characterized_object =>
piping_component_class}
shape_aspect
shape_definition = shape_aspect
shape_definition
characterized_definition = shape_definition
characterized_definition <-
property_definition.definition
property_definition
represented_definition = property_definition
represented_definition <-
property_definition_representation.definition
property_definition_representation
property_definition_representation.used_representation ->
{representation
representation.name = 'piping connector class dimension'}
representation
(representation.items[i] ->
{representation_item
(representation_item.name = 'maximum flange inside diameter')
(representation_item.name = 'minimum flange inside diameter'}})
([representation.items[i] ->
{representation_item
representation_item.name = 'maximum flange inside diameter'}}]
[representation.items[i] ->
{representation_item
representation_item.name = 'minimum flange inside diameter'}}]))
representation_item =>
measure_representation_item <=
{measure_with_unit =>
length_measure_with_unit}
measure_with_unit
[measure_with_unit.value_component]
[measure_with_unit.unit_component]

```

### 5.1.4.15.3 flange\_outside\_diameter

#1: The diameter is for the individual connector.

#2: The diameter is for the definition of a family of piping components.

AIM element: [measure\_with\_unit.value\_component]  
[measure\_with\_unit.unit\_component]

Source: 41

Rules: subtype\_exclusive\_characterized\_object  
subtype\_mandatory\_shape\_representation

Reference path: plant\_item\_connector <=  
#1: (shape\_aspect <-

```

dimensional_size.applies_to
dimensional_size
dimensional_characteristic = dimensional_size
dimensional_characteristic <-
dimensional_characteristic_representation.dimension
dimensional_characteristic_representation
dimensional_characteristic_representation.representation ->
shape_dimension_representation <=
shape_representation <=
{representation
representation.name = 'piping connector dimensional shape'}
representation
representation.items[i] ->
{representation_item
representation_item.name = 'flange outside diameter'})
#2: ({shape_aspect
shape_aspect.of_shape ->
product_definition_shape <=
property_definition
property_definition.definition ->
characterized_definition
characterized_definition = characterized_object
characterized_object =>
piping_component_class}
shape_aspect
shape_definition = shape_aspect
shape_definition
characterized_definition = shape_definition
characterized_definition <-
property_definition.definition
property_definition
represented_definition = property_definition
represented_definition <-
property_definition_representation.definition
property_definition_representation
property_definition_representation.used_representation ->
{representation
representation.name = 'piping connector class dimension'}
representation
(representation.items[i] ->
{representation_item
(representation_item.name = 'maximum flange outside diameter')
(representation_item.name = 'minimum flange outside diameter'))}
([representation.items[i] ->
{representation_item
representation_item.name = 'maximum flange outside diameter'}]
[representation.items[i] ->
{representation_item
representation_item.name = 'minimum flange outside diameter'}}]))
representation_item =>
measure_representation_item <=
{measure_with_unit =>
length_measure_with_unit}
measure_with_unit

```

[measure\_with\_unit.value\_component]  
 [measure\_with\_unit.unit\_component]

#### 5.1.4.15.4 flange\_thickness

#1: The thickness is for the individual connector.

#2: The thickness is for the definition of a family of piping components.

AIM element: [measure\_with\_unit.value\_component]  
 [measure\_with\_unit.unit\_component]

Source: 41

Rules: subtype\_exclusive\_characterized\_object  
 subtype\_mandatory\_shape\_representation

Reference path: plant\_item\_connector <=  
 #1: (shape\_aspect <-  
 [shape\_aspect\_relationship.relate\_shape\_aspect  
 {shape\_aspect\_relationship  
 shape\_aspect\_relationship.name = 'connector dimensional aspect'}  
 shape\_aspect\_relationship  
 shape\_aspect\_relationship.related\_shape\_aspect ->  
 shape\_aspect <-  
 shape\_aspect\_relationship.relate\_shape\_aspect]  
 [shape\_aspect\_relationship.relate\_shape\_aspect  
 {shape\_aspect\_relationship  
 shape\_aspect\_relationship.name = 'connector dimensional aspect'}  
 shape\_aspect\_relationship  
 shape\_aspect\_relationship.related\_shape\_aspect ->  
 shape\_aspect <-  
 shape\_aspect\_relationship.related\_shape\_aspect]  
 shape\_aspect\_relationship =>  
 dimensional\_location  
 dimensional\_characteristic = dimensional\_location  
 dimensional\_characteristic <-  
 dimensional\_characteristic\_representation.dimension  
 dimensional\_characteristic\_representation  
 dimensional\_characteristic\_representation.representation ->  
 shape\_dimension\_representation <=  
 shape\_representation <=  
 {representation  
 representation.name = 'piping connector dimensional shape'}  
 representation  
 representation.items[i] ->  
 {representation\_item  
 representation\_item.name = 'flange thickness'})  
 #2: ({shape\_aspect  
 shape\_aspect.of\_shape ->  
 product\_definition\_shape <=  
 property\_definition  
 property\_definition.definition ->  
 characterized\_definition

```

characterized_definition = characterized_object
characterized_object =>
  piping_component_class}
shape_aspect
shape_definition = shape_aspect
shape_definition
characterized_definition = shape_definition
characterized_definition <-
  property_definition.definition
property_definition
represented_definition = property_definition
represented_definition <-
  property_definition_representation.definition
property_definition_representation
property_definition_representation.used_representation ->
  {representation
  representation.name = 'piping connector class dimension'}
representation
(representation.items[i] ->
  {representation_item
  (representation_item.name = 'maximum flange thickness')
  (representation_item.name = 'minimum flange thickness'}})
([representation.items[i] ->
  {representation_item
  representation_item.name = 'maximum flange thickness'}}
[representation.items[i] ->
  {representation_item
  representation_item.name = 'minimum flange thickness'}})])
representation_item =>
  measure_representation_item <=
  {measure_with_unit =>
  length_measure_with_unit}
measure_with_unit
[measure_with_unit.value_component]
[measure_with_unit.unit_component]

```

#### 5.1.4.15.5 raised\_face\_diameter

#1: The diameter is for the individual connector.

#2: The diameter is for the definition of a family of piping components.

AIM element: [measure\_with\_unit.value\_component]  
[measure\_with\_unit.unit\_component]

Source: 41

Rules: subtype\_exclusive\_characterized\_object  
subtype\_mandatory\_externally\_defined\_item

Reference path: plant\_item\_connector <=  
#1: (shape\_aspect <-  
dimensional\_size.applies\_to  
dimensional\_size

```

dimensional_characteristic = dimensional_size
dimensional_characteristic <-
dimensional_characteristic_representation.dimension
dimensional_characteristic_representation
dimensional_characteristic_representation.representation ->
shape_dimension_representation <=
shape_representation <=
{representation
representation.name = 'piping connector dimensional shape'}
representation
representation.items[i] ->
{representation_item
representation_item.name = 'raised face diameter'})
#2: ({shape_aspect
shape_aspect.of_shape ->
product_definition_shape <=
property_definition
property_definition.definition ->
characterized_definition
characterized_definition = characterized_object
characterized_object =>
piping_component_class}
shape_aspect
shape_definition = shape_aspect
shape_definition
characterized_definition = shape_definition
characterized_definition <-
property_definition.definition
property_definition
represented_definition = property_definition
represented_definition <-
property_definition_representation.definition
property_definition_representation
property_definition_representation.used_representation ->
{representation
representation.name = 'piping connector class dimension'}
representation
(representation.items[i] ->
{representation_item
(representation_item.name = 'maximum raised face diameter')
(representation_item.name = 'minimum raised face diameter'))
([representation.items[i] ->
{representation_item
representation_item.name = 'maximum raised face diameter'}]
[representation.items[i] ->
{representation_item
representation_item.name = 'minimum raised face diameter'}]))
representation_item =>
measure_representation_item <=
{measure_with_unit =>
length_measure_with_unit}
measure_with_unit
[measure_with_unit.value_component]

```

[measure\_with\_unit.unit\_component]

### 5.1.4.15.6 raised\_face\_height

#1: The height is for the individual connector.

#2: The height is for the definition of a family of piping components.

AIM element: [measure\_with\_unit.value\_component]  
[measure\_with\_unit.unit\_component]

Source: 41

Rules: subtype\_exclusive\_characterized\_object  
subtype\_mandatory\_externally\_defined\_item

Reference path: plant\_item\_connector <=  
#1: (shape\_aspect <-  
[shape\_aspect\_relationship.relate\_shape\_aspect  
{shape\_aspect\_relationship  
shape\_aspect\_relationship.name = 'connector dimensional aspect'}  
shape\_aspect\_relationship  
shape\_aspect\_relationship.related\_shape\_aspect ->  
shape\_aspect <-  
shape\_aspect\_relationship.relate\_shape\_aspect]  
[shape\_aspect\_relationship.relate\_shape\_aspect  
{shape\_aspect\_relationship  
shape\_aspect\_relationship.name = 'connector dimensional aspect'}  
shape\_aspect\_relationship  
shape\_aspect\_relationship.related\_shape\_aspect ->  
shape\_aspect <-  
shape\_aspect\_relationship.related\_shape\_aspect]  
shape\_aspect\_relationship =>  
dimensional\_location  
dimensional\_characteristic = dimensional\_location  
dimensional\_characteristic <-  
dimensional\_characteristic\_representation.dimension  
dimensional\_characteristic\_representation  
dimensional\_characteristic\_representation.representation ->  
shape\_dimension\_representation <=  
shape\_representation <=  
{representation  
representation.name = 'piping connector dimensional shape'}  
representation  
representation.items[i] ->  
{representation\_item  
representation\_item.name = 'raised face height'})  
#2: ({shape\_aspect  
shape\_aspect.of\_shape ->  
product\_definition\_shape <=  
property\_definition  
property\_definition.definition ->  
characterized\_definition  
characterized\_definition = characterized\_object

```

characterized_object =>
  piping_component_class}
  shape_aspect
  shape_definition = shape_aspect
  shape_definition
  characterized_definition = shape_definition
  characterized_definition <-
  property_definition.definition
  property_definition
  represented_definition = property_definition
  represented_definition <-
  property_definition_representation.definition
  property_definition_representation
  property_definition_representation.used_representation ->
  {representation
  representation.name = 'piping connector class dimension'}
  representation
  (representation.items[i] ->
  {representation_item
  (representation_item.name = 'maximum raised face height')
  (representation_item.name = 'minimum raised face height'}})
  ([representation.items[i] ->
  {representation_item
  representation_item.name = 'maximum raised face height'}}]
  [representation.items[i] ->
  {representation_item
  representation_item.name = 'minimum raised face height'}}]))
  representation_item =>
  measure_representation_item <=
  {measure_with_unit =>
  length_measure_with_unit}
  measure_with_unit
  [measure_with_unit.value_component]
  [measure_with_unit.unit_component]

```

#### 5.1.4.15.7 ring\_bottom\_radius

AIM element: [measure\_with\_unit.value\_component]  
[measure\_with\_unit.unit\_component]

Source: 41

Rules: subtype\_mandatory\_shape\_representation

Reference path: plant\_item\_connector <=  
shape\_aspect <-  
dimensional\_size.applies\_to  
dimensional\_size  
dimensional\_characteristic = dimensional\_size  
dimensional\_characteristic <-  
dimensional\_characteristic\_representation.dimension  
dimensional\_characteristic\_representation  
dimensional\_characteristic\_representation.representation ->  
shape\_dimension\_representation <=

```

shape_representation <=
{representation
representation.name = 'piping connector dimensional shape'}
representation
representation.items[i] ->
{representation_item
representation_item.name = 'ring bottom radius'}
representation_item =>
measure_representation_item <=
{measure_with_unit =>
length_measure_with_unit}
measure_with_unit
[measure_with_unit.value_component]
[measure_with_unit.unit_component]

```

#### 5.1.4.15.8 ring\_diameter

AIM element: [measure\_with\_unit.value\_component]  
[measure\_with\_unit.unit\_component]

Source: 41

Reference path:

```

plant_item_connector <=
shape_aspect <-
dimensional_size.applies_to
dimensional_size
dimensional_characteristic = dimensional_size
dimensional_characteristic <-
dimensional_characteristic_representation.dimension
dimensional_characteristic_representation
dimensional_characteristic_representation.representation ->
shape_dimension_representation <=
shape_representation <=
{representation
representation.name = 'piping connector dimensional shape'}
representation
representation.items[i] ->
{representation_item
representation_item.name = 'ring diameter'}
representation_item =>
measure_representation_item <=
{measure_with_unit =>
length_measure_with_unit}
measure_with_unit
[measure_with_unit.value_component]
[measure_with_unit.unit_component]

```

#### 5.1.4.15.9 ring\_width

AIM element: [measure\_with\_unit.value\_component]  
[measure\_with\_unit.unit\_component]

Source: 41

Rules: subtype\_mandatory\_shape\_representation

Reference path: plant\_item\_connector <=  
 shape\_aspect <=  
 [shape\_aspect\_relationship.relying\_shape\_aspect  
 {shape\_aspect\_relationship  
 shape\_aspect\_relationship.name = 'connector dimensional aspect'}  
 shape\_aspect\_relationship  
 shape\_aspect\_relationship.related\_shape\_aspect ->  
 shape\_aspect <=  
 shape\_aspect\_relationship.relying\_shape\_aspect]  
 [shape\_aspect\_relationship.relying\_shape\_aspect  
 {shape\_aspect\_relationship  
 shape\_aspect\_relationship.name = 'connector dimensional aspect'}  
 shape\_aspect\_relationship  
 shape\_aspect\_relationship.related\_shape\_aspect ->  
 shape\_aspect <=  
 shape\_aspect\_relationship.related\_shape\_aspect]  
 shape\_aspect\_relationship =>  
 dimensional\_location  
 dimensional\_characteristic = dimensional\_location  
 dimensional\_characteristic <=  
 dimensional\_characteristic\_representation.dimension  
 dimensional\_characteristic\_representation  
 dimensional\_characteristic\_representation.representation ->  
 shape\_dimension\_representation <=  
 shape\_representation <=  
 {representation  
 representation.name = 'piping connector dimensional shape'}  
 representation  
 representation.items[i] ->  
 {representation\_item  
 representation\_item.name = 'ring width'}  
 representation\_item =>  
 measure\_representation\_item <=  
 {measure\_with\_unit =>  
 length\_measure\_with\_unit}  
 measure\_with\_unit  
 [measure\_with\_unit.value\_component]  
 [measure\_with\_unit.unit\_component]

#### 5.1.4.15.10 face\_type

AIM element: descriptive\_representation\_item.description

Source: 45

Reference path: plant\_item\_connector <=  
 shape\_aspect  
 shape\_definition = shape\_aspect  
 shape\_definition  
 characterized\_definition = shape\_definition

```

characterized_definition <-
property_definition.definition
property_definition
represented_definition = property_definition
represented_definition <-
property_definition_representation.definition
property_definition_representation
property_definition_representation.used_representation ->
representation
representation.items[i] ->
{representation_item
representation_item.name = 'face type'}
representation_item =>
descriptive_representation_item
descriptive_representation_item.description

```

### 5.1.4.16 Flared\_end

AIM element: plant\_item\_connector

Source: 227

Reference path: plant\_item\_connector <=

```

shape_aspect
{plant_item_connector
classification_item = plant_item_connector
classification_item <-
applied_classification_assignment.items[i]
applied_classification_assignment <=
classification_assignment
classification_assignment.assigned_group ->
[group =>
connector_end_type_class]
[group
group.name = 'flared end']}

```

#### 5.1.4.16.1 diameter

#1: The diameter is for the individual connector.

#2: The diameter is for the definition of a family of piping components.

AIM element: [measure\_with\_unit.value\_component]  
[measure\_with\_unit.unit\_component]

Source: 41

Rules: subtype\_exclusive\_characterized\_object  
subtype\_mandatory\_shape\_representation

Reference path: plant\_item\_connector <=

```

#1: (shape_aspect <-
[shape_aspect_relationship.relatng_shape_aspect

```

```

{shape_aspect_relationship
shape_aspect_relationship.name = 'connector dimensional aspect'}
shape_aspect_relationship
shape_aspect_relationship.related_shape_aspect ->
shape_aspect <-
shape_aspect_relationship.relate_shape_aspect]
[shape_aspect_relationship.relate_shape_aspect
{shape_aspect_relationship
shape_aspect_relationship.name = 'connector dimensional aspect'}
shape_aspect_relationship
shape_aspect_relationship.related_shape_aspect ->
shape_aspect <-
shape_aspect_relationship.related_shape_aspect]
shape_aspect_relationship =>
dimensional_location
dimensional_characteristic = dimensional_location
dimensional_characteristic <-
dimensional_characteristic_representation.dimension
dimensional_characteristic_representation
dimensional_characteristic_representation.representation ->
shape_dimension_representation <=
shape_representation <=
{representation
representation.name = 'piping connector dimensional shape'}
representation
representation.items[i] ->
{representation_item
representation_item.name = 'diameter'})

#2: ({shape_aspect
shape_aspect.of_shape ->
product_definition_shape <=
property_definition
property_definition.definition ->
characterized_definition
characterized_definition = characterized_object
characterized_object =>
piping_component_class}
shape_aspect
shape_definition = shape_aspect
shape_definition
characterized_definition = shape_definition
characterized_definition <-
property_definition.definition
property_definition
represented_definition = property_definition
represented_definition <-
property_definition_representation.definition
property_definition_representation
property_definition_representation.used_representation ->
{representation
representation.name = 'piping connector class dimension'}
representation
(representation.items[i] ->

```

```

{representation_item
(representation_item.name = 'maximum diameter')
(representation_item.name = 'minimum diameter'))
([representation.items[i] ->
{representation_item
representation_item.name = 'maximum diameter'}]
[representation.items[i] ->
{representation_item
representation_item.name = 'minimum diameter'}]))
representation_item =>
measure_representation_item <=
{measure_with_unit =>
length_measure_with_unit}
measure_with_unit
[measure_with_unit.value_component]
[measure_with_unit.unit_component]

```

### 5.1.4.16.2 thickness

#1: The thickness is for the individual connector.

#2: The thickness is for the definition of a family of piping components.

AIM element: [measure\_with\_unit.value\_component]  
[measure\_with\_unit.unit\_component]

Source: 41

Rules: subtype\_exclusive\_characterized\_object  
subtype\_mandatory\_shape\_representation

Reference path: plant\_item\_connector <=

```

#1: (shape_aspect <-
[shape_aspect_relationship.relate_shape_aspect
{shape_aspect_relationship
shape_aspect_relationship.name = 'connector dimensional aspect'}
shape_aspect_relationship
shape_aspect_relationship.related_shape_aspect ->
shape_aspect <-
shape_aspect_relationship.relate_shape_aspect]
[shape_aspect_relationship.relate_shape_aspect
{shape_aspect_relationship
shape_aspect_relationship.name = 'connector dimensional aspect'}
shape_aspect_relationship
shape_aspect_relationship.related_shape_aspect ->
shape_aspect <-
shape_aspect_relationship.related_shape_aspect]
shape_aspect_relationship =>
dimensional_location
dimensional_characteristic = dimensional_location
dimensional_characteristic <-
dimensional_characteristic_representation.dimension
dimensional_characteristic_representation
dimensional_characteristic_representation.representation ->

```

```

shape_dimension_representation <=
shape_representation <=
{representation
representation.name = 'piping connector dimensional shape'}
representation
representation.items[i] ->
{representation_item
representation_item.name = 'thickness'})

#2: ({shape_aspect
shape_aspect.of_shape ->
product_definition_shape <=
property_definition
property_definition.definition ->
characterized_definition
characterized_definition = characterized_object
characterized_object =>
piping_component_class}
shape_aspect
shape_definition = shape_aspect
shape_definition
characterized_definition = shape_definition
characterized_definition <-
property_definition.definition
property_definition
represented_definition = property_definition
represented_definition <-
property_definition_representation.definition
property_definition_representation
property_definition_representation.used_representation ->
{representation
representation.name = 'piping connector class dimension'}
representation
(representation.items[i] ->
{representation_item
(representation_item.name = 'maximum thickness')
(representation_item.name = 'minimum thickness'}})
([representation.items[i] ->
{representation_item
representation_item.name = 'maximum thickness'}]
[representation.items[i] ->
{representation_item
representation_item.name = 'minimum thickness'}}]))
representation_item =>
measure_representation_item <=
{measure_with_unit =>
length_measure_with_unit}
measure_with_unit
[measure_with_unit.value_component]
[measure_with_unit.unit_component]

```

#### 5.1.4.17 Functional\_connector

AIM element: plant\_item\_connector

Source: 227

Reference path: plant\_item\_connector <=  
shape\_aspect  
{ shape\_aspect  
shape\_aspect.of\_shape ->  
product\_definition\_shape <=  
property\_definition  
property\_definition.definition ->  
characterized\_definition  
characterized\_definition = characterized\_product\_definition  
characterized\_product\_definition  
characterized\_product\_definition = product\_definition  
product\_definition  
product\_definition.frame\_of\_reference ->  
product\_definition\_context <=  
application\_context\_element  
application\_context\_element.name = 'functional occurrence'}

#### **5.1.4.17.1 functional\_connector to functional\_connector\_occurrence - satisfaction**

AIM element: PATH

Reference path: plant\_item\_connector <=  
shape\_aspect <-  
shape\_aspect\_relationship.relate\_shape\_aspect  
{ shape\_aspect\_relationship  
shape\_aspect\_relationship.name = 'connector occurrence satisfaction'}

#### **5.1.4.18 Functional\_connector\_definition\_satisfaction**

AIM element: shape\_aspect\_relationship

Source: 41

Reference path: { shape\_aspect\_relationship  
shape\_aspect\_relationship.name = 'connector definition satisfaction'}

#### **5.1.4.19 Functional\_connector\_occurrence\_satisfaction**

AIM element: shape\_aspect\_relationship

Source: 41

Reference path: { shape\_aspect\_relationship  
shape\_aspect\_relationship.name = 'connector occurrence satisfaction'}

### 5.1.4.20 Grooved\_end

AIM element: plant\_item\_connector

Source: 227

Reference path: plant\_item\_connector <=  
 shape\_aspect  
 {plant\_item\_connector  
 classification\_item = plant\_item\_connector  
 classification\_item <=  
 applied\_classification\_assignment.items[i]  
 applied\_classification\_assignment <=  
 classification\_assignment  
 classification\_assignment.assigned\_group ->  
 [group =>  
 connector\_end\_type\_class]  
 [group  
 group.name = 'grooved end']}

#### 5.1.4.20.1 width

#1: The width is for the individual connector.

#2: The width is for the definition of a family of piping components.

AIM element: [measure\_with\_unit.value\_component]  
 [measure\_with\_unit.unit\_component]

Source: 41

Rules: subtype\_exclusive\_characterized\_object  
 subtype\_mandatory\_shape\_representation

Reference path: plant\_item\_connector <=  
 #1: (shape\_aspect <=  
 [shape\_aspect\_relationship.relating\_shape\_aspect  
 {shape\_aspect\_relationship  
 shape\_aspect\_relationship.name = 'connector dimensional aspect'}  
 shape\_aspect\_relationship  
 shape\_aspect\_relationship.related\_shape\_aspect ->  
 shape\_aspect <=  
 shape\_aspect\_relationship.relating\_shape\_aspect]  
 [shape\_aspect\_relationship.relating\_shape\_aspect  
 {shape\_aspect\_relationship  
 shape\_aspect\_relationship.name = 'connector dimensional aspect'}  
 shape\_aspect\_relationship  
 shape\_aspect\_relationship.related\_shape\_aspect ->  
 shape\_aspect <=  
 shape\_aspect\_relationship.related\_shape\_aspect]  
 shape\_aspect\_relationship =>  
 dimensional\_location  
 dimensional\_characteristic = dimensional\_location  
 dimensional\_characteristic <=

```

dimensional_characteristic_representation.dimension
dimensional_characteristic_representation
dimensional_characteristic_representation.representation ->
shape_dimension_representation <=
shape_representation <=
{representation
representation.name = 'piping connector dimensional shape'}
representation
representation.items[i] ->
{representation_item
representation_item.name = 'width'})

#2: ({shape_aspect
shape_aspect.of_shape ->
product_definition_shape <=
property_definition
property_definition.definition ->
characterized_definition
characterized_definition = characterized_object
characterized_object =>
piping_component_class}
shape_aspect
shape_definition = shape_aspect
shape_definition
characterized_definition = shape_definition
characterized_definition <-
property_definition.definition
property_definition
represented_definition = property_definition
represented_definition <-
property_definition_representation.definition
property_definition_representation
property_definition_representation.used_representation ->
{representation
representation.name = 'piping connector class dimension'}
representation
(representation.items[i] ->
{representation_item
(representation_item.name = 'maximum width')
(representation_item.name = 'minimum width')}))
([representation.items[i] ->
{representation_item
representation_item.name = 'maximum width'}]
[representation.items[i] ->
{representation_item
representation_item.name = 'minimum width'}]))
representation_item =>
measure_representation_item <=
{measure_with_unit =>
length_measure_with_unit}
measure_with_unit
[measure_with_unit.value_component]
[measure_with_unit.unit_component]

```

### 5.1.4.20.2 depth

#1: The depth is for the individual connector.

#2: The depth is for the definition of a family of piping components.

AIM element: [measure\_with\_unit.value\_component]  
[measure\_with\_unit.unit\_component]

Source: 41

Rules: subtype\_exclusive\_characterized\_object  
subtype\_mandatory\_shape\_representation

Reference path: plant\_item\_connector <=  
#1: (shape\_aspect <-  
[shape\_aspect\_relationship.relate\_shape\_aspect  
{shape\_aspect\_relationship  
shape\_aspect\_relationship.name = 'connector dimensional aspect'}  
shape\_aspect\_relationship  
shape\_aspect\_relationship.related\_shape\_aspect ->  
shape\_aspect <-  
shape\_aspect\_relationship.relate\_shape\_aspect]  
[shape\_aspect\_relationship.relate\_shape\_aspect  
{shape\_aspect\_relationship  
shape\_aspect\_relationship.name = 'connector dimensional aspect'}  
shape\_aspect\_relationship  
shape\_aspect\_relationship.related\_shape\_aspect ->  
shape\_aspect <-  
shape\_aspect\_relationship.related\_shape\_aspect]  
shape\_aspect\_relationship =>  
dimensional\_location  
dimensional\_characteristic = dimensional\_location  
dimensional\_characteristic <-  
dimensional\_characteristic\_representation.dimension  
dimensional\_characteristic\_representation  
dimensional\_characteristic\_representation.representation ->  
shape\_dimension\_representation <=  
shape\_representation <=  
{representation  
representation.name = 'piping connector dimensional shape'}  
representation  
representation.items[i] ->  
{representation\_item  
representation\_item.name = 'depth'})  
  
#2: ({shape\_aspect  
shape\_aspect.of\_shape ->  
product\_definition\_shape <=  
property\_definition  
property\_definition.definition ->  
characterized\_definition  
characterized\_definition = characterized\_object  
characterized\_object =>

```

    piping_component_class}
    shape_aspect
    shape_definition = shape_aspect
    shape_definition
    characterized_definition = shape_definition
    characterized_definition <-
    property_definition.definition
    property_definition
    represented_definition = property_definition
    represented_definition <-
    property_definition_representation.definition
    property_definition_representation
    property_definition_representation.used_representation ->
    {representation
    representation.name = 'piping connector class dimension'}
    representation
    (representation.items[i] ->
    {representation_item
    (representation_item.name = 'maximum depth')
    (representation_item.name = 'minimum depth'}})
    ([representation.items[i] ->
    {representation_item
    representation_item.name = 'maximum depth'}}]
    [representation.items[i] ->
    {representation_item
    representation_item.name = 'minimum depth'}}]))
    representation_item =>
    measure_representation_item <=
    {measure_with_unit =>
    length_measure_with_unit}
    measure_with_unit
    [measure_with_unit.value_component]
    [measure_with_unit.unit_component]

```

### 5.1.4.20.3 distance\_from\_end

#1: The distance\_from\_end is for the individual connector.

#2: The distance\_from\_end is for the definition of a family of piping components.

AIM element: [measure\_with\_unit.value\_component]  
[measure\_with\_unit.unit\_component]

Source: 41

Rules: subtype\_exclusive\_characterized\_object  
subtype\_mandatory\_shape\_representation

Reference path: plant\_item\_connector <=  
#1: (shape\_aspect <-  
[shape\_aspect\_relationship.relating\_shape\_aspect  
{shape\_aspect\_relationship  
shape\_aspect\_relationship.name = 'connector dimensional aspect'}  
shape\_aspect\_relationship

```

shape_aspect_relationship.related_shape_aspect ->
shape_aspect <-
shape_aspect_relationship.relying_shape_aspect]
[shape_aspect_relationship.relying_shape_aspect
{shape_aspect_relationship
shape_aspect_relationship.name = 'connector dimensional aspect'}
shape_aspect_relationship
shape_aspect_relationship.related_shape_aspect ->
shape_aspect <-
shape_aspect_relationship.related_shape_aspect]
shape_aspect_relationship =>
dimensional_location
dimensional_characteristic = dimensional_location
dimensional_characteristic <-
dimensional_characteristic_representation.dimension
dimensional_characteristic_representation
dimensional_characteristic_representation.representation ->
shape_dimension_representation <=
shape_representation <=
{representation
representation.name = 'piping connector dimensional shape'}
representation
representation.items[i] ->
{representation_item
representation_item.name = 'distance from end'})

#2: ({shape_aspect
shape_aspect.of_shape ->
product_definition_shape <=
property_definition
property_definition.definition ->
characterized_definition
characterized_definition = characterized_object
characterized_object =>
piping_component_class}
shape_aspect
shape_definition = shape_aspect
shape_definition
characterized_definition = shape_definition
characterized_definition <-
property_definition.definition
property_definition
represented_definition = property_definition
represented_definition <-
property_definition_representation.definition
property_definition_representation
property_definition_representation.used_representation ->
{representation
representation.name = 'piping connector class dimension'}
representation
(representation.items[i] ->
{representation_item
(representation_item.name = 'maximum distance from end')
(representation_item.name = 'minimum distance from end'))})

```

```

([representation.items[i] ->
 {representation_item
 representation_item.name = 'maximum distance from end'}}]
 [representation.items[i] ->
 {representation_item
 representation_item.name = 'minimum distance from end'}}]))
 representation_item =>
 measure_representation_item <=
 {measure_with_unit =>
 length_measure_with_unit}
 measure_with_unit
 [measure_with_unit.value_component]
 [measure_with_unit.unit_component]

```

#### 5.1.4.21 Hvac\_connector

AIM element: hvac\_connector

Source: 227

Reference path: hvac\_connector <=  
 shape\_aspect  
 {shape\_aspect  
 shape\_aspect.product\_definitional = TRUE}

##### 5.1.4.21.1 name

AIM element: shape\_aspect.name

Source: 41

Reference path: hvac\_connector <=  
 shape\_aspect  
 shape\_aspect.name

##### 5.1.4.21.2 hvac\_connector\_specification

AIM element: document

Source: 41

Reference path: hvac\_connector  
 document\_item = hvac\_connector  
 document\_item <=  
 applied\_document\_reference.items[i]  
 applied\_document\_reference <=  
 document\_reference  
 document\_reference.assigned\_document ->  
 {document  
 document.kind ->  
 document\_type  
 document\_type.product\_data\_type = 'hvac connector specification'}

document

#### 5.1.4.21.3 hvac\_joint\_inspection\_specification

AIM element: document

Source: 41

Reference path: hvac\_connector  
 document\_item = hvac\_connector  
 document\_item <-  
 applied\_document\_reference.items[i]  
 applied\_document\_reference <=  
 document\_reference  
 document\_reference.assigned\_document ->  
 {document  
 document.kind ->  
 document\_type  
 document\_type.product\_data\_type = 'hvac connector inspection specification'}  
 document

#### 5.1.4.21.4 connector\_flow\_direction

AIM element: descriptive\_representation\_item.description

Source: 45

Reference path: hvac\_connector <=  
 shape\_aspect  
 shape\_definition = shape\_aspect  
 shape\_definition  
 characterized\_definition = shape\_definition  
 characterized\_definition <-  
 property\_definition.definition  
 property\_definition  
 represented\_definition = property\_definition  
 represented\_definition <-  
 property\_definition\_representation.definition  
 property\_definition\_representation  
 property\_definition\_representation.used\_representation ->  
 representation  
 {representation.name = 'hvac connector characteristics'}  
 representation.items[i] ->  
 {representation\_item  
 representation\_item.name = 'flow direction'}  
 representation\_item =>  
 descriptive\_representation\_item  
 descriptive\_representation\_item.description

#### 5.1.4.21.5 hvac\_joint\_test\_specification

AIM element: document

Source: 41

Reference path: hvac\_connector  
 document\_item = hvac\_connector  
 document\_item <-  
 applied\_document\_reference.items[i]  
 applied\_document\_reference <=  
 document\_reference  
 document\_reference.assigned\_document ->  
 {document  
 document.kind ->  
 document\_type  
 document\_type.product\_data\_type = 'hvac connector test specification'}  
 document

#### 5.1.4.21.6 hvac\_joint\_engagement\_length

AIM element: [measure\_with\_unit.value\_component]  
 [measure\_with\_unit.unit\_component]

Source: 41

Reference path: hvac\_connector <=  
 shape\_aspect  
 shape\_definition = shape\_aspect  
 shape\_definition  
 characterized\_definition = shape\_definition  
 characterized\_definition <-  
 property\_definition.definition  
 property\_definition  
 represented\_definition = property\_definition  
 represented\_definition <-  
 property\_definition\_representation.definition  
 property\_definition\_representation  
 property\_definition\_representation.used\_representation ->  
 representation  
 representation.items[i] ->  
 representation\_item =>  
 {representation\_item.name = 'engagement length'}  
 measure\_representation\_item <=  
 {measure\_with\_unit =>  
 length\_measure\_with\_unit}  
 measure\_with\_unit  
 [measure\_with\_unit.value\_component]  
 [measure\_with\_unit.unit\_component]

#### 5.1.4.21.7 hvac\_joint\_joining\_type

AIM element: group.name

Source: 41

Reference path: hvac\_connector

```

classification_item = hvac_connector
classification_item <-
applied_classification_assignment.items[i]
applied_classification_assignment <=
{classification_assignment
classification_assignment.role ->
classification_role
classification_role.name = 'hvac joint joining type classification'}
classification_assignment
classification_assignment.assigned_classification ->
group
group.name

```

#### 5.1.4.21.8 hvac\_joint\_sealant\_type

AIM element: group.name

Source: 41

Reference path:

```

hvac_connector
classification_item = hvac_connector
classification_item <-
applied_classification_assignment.items[i]
applied_classification_assignment <=
{classification_assignment
classification_assignment.role ->
classification_role
classification_role.name = 'hvac joint sealant type classification'}
classification_assignment
classification_assignment.assigned_classification ->
group
group.name

```

#### 5.1.4.21.9 hvac\_joint\_joint\_type

AIM element: group.name

Source: 41

Reference path:

```

hvac_connector
classification_item = hvac_connector
classification_item <-
applied_classification_assignment.items[i]
applied_classification_assignment <=
{classification_assignment
classification_assignment.role ->
classification_role
classification_role.name = 'hvac joint type classification'}
classification_assignment
classification_assignment.assigned_classification ->
group
group.name

```

**5.1.4.21.10 hvac\_joint\_tightness**

AIM element: group.name

Source: 41

Reference path: hvac\_connector  
 classification\_item = hvac\_connector  
 classification\_item <-  
 applied\_classification\_assignment.items[i]  
 applied\_classification\_assignment <=  
 {classification\_assignment  
 classification\_assignment.role ->  
 classification\_role  
 classification\_role.name = 'hvac joint tightness classification'}  
 classification\_assignment  
 classification\_assignment.assigned\_classification ->  
 group  
 group.name

**5.1.4.21.11 hvac\_connector to hvac\_cross\_section**

AIM element: PATH

Reference path: hvac\_connector <=  
 shape\_aspect <-  
 shape\_aspect\_relationship.relate\_shape\_aspect  
 shape\_aspect\_relationship  
 shape\_aspect\_relationship.related\_shape\_aspect ->  
 shape\_aspect =>  
 hvac\_cross\_section

**5.1.4.21.12 hvac\_connector to hvac\_connector\_service\_characteristic**

AIM element: PATH

Reference path: hvac\_connector <=  
 shape\_aspect  
 shape\_definition = shape\_aspect  
 shape\_definition  
 characterized\_definition = shape\_definition  
 characterized\_definition <-  
 property\_definition.definition  
 {property\_definition  
 property\_definition.name = 'hvac service characteristics'}  
 property\_definition

**5.1.4.22 Hvac\_connector\_service\_characteristic**

AIM element: property\_definition

Source: 41

Reference path:   property\_definition  
                       {property\_definition.name = 'hvac service characteristic'}

#### 5.1.4.22.1   **design\_pressure**

AIM element:       [measure\_with\_unit.value\_component]  
                       [measure\_with\_unit.unit\_component]

Source:            41

Reference path:   property\_definition  
                       represented\_definition = property\_definition  
                       represented\_definition <-  
                       property\_definition\_representation.definition  
                       property\_definition\_representation  
                       property\_definition\_representation.using\_representation ->  
                       representation  
                       {representation.name = 'design service characteristics'}  
                       (representation.items[i] ->  
                       {representation\_item  
                       (representation\_item.name = 'pressure')  
                       (representation\_item.name = 'maximum pressure')  
                       (representation\_item.name = 'minimum pressure'}})  
                       ([representation.items[i] ->  
                       {representation\_item  
                       representation\_item.name = 'maximum pressure'}}]  
                       [representation.items[i] ->  
                       {representation\_item  
                       representation\_item.name = 'minimum pressure'}}])  
                       representation\_item =>  
                       measure\_representation\_item <=  
                       measure\_with\_unit  
                       [measure\_with\_unit.value\_component]  
                       [measure\_with\_unit.unit\_component]

#### 5.1.4.22.2   **design\_temperature**

AIM element:       [measure\_with\_unit.value\_component]  
                       [measure\_with\_unit.unit\_component]

Source:            41

Reference path:   property\_definition  
                       represented\_definition = property\_definition  
                       represented\_definition <-  
                       property\_definition\_representation.definition  
                       property\_definition\_representation  
                       property\_definition\_representation.using\_representation ->  
                       representation  
                       {representation.name = 'design service characteristics'}  
                       (representation.items[i] ->  
                       {representation\_item  
                       (representation\_item.name = 'temperature')  
                       }

```

(representation_item.name = 'maximum temperature')
(representation_item.name = 'minimum temperature'))
([representation.items[i] ->
 {representation_item
 representation_item.name = 'maximum temperature'}}
 [representation.items[i] ->
 {representation_item
 representation_item.name = 'minimum temperature'}}])
representation_item =>
measure_representation_item <=
measure_with_unit
[measure_with_unit.value_component]
[measure_with_unit.unit_component]

```

### 5.1.4.22.3 hvac\_connector\_service\_characteristic to service\_operating\_-case

AIM element: PATH

Reference path: property\_definition <-  
property\_definition\_relationship.related\_property\_definition  
property\_definition\_relationship

### 5.1.4.23 Hvac\_cross\_section

AIM element: hvac\_cross\_section

Source: 227

Reference path: hvac\_cross\_section <=  
shape\_aspect

#### 5.1.4.23.1 equivalent\_length

AIM element: [measure\_with\_unit.value\_component]  
[measure\_with\_unit.unit\_component]

Source: 41

Rules: subtype\_mandatory\_shape\_representation

Reference path: hvac\_cross\_section <=  
shape\_aspect <-  
[shape\_aspect\_relationship.relate\_shape\_aspect  
{shape\_aspect\_relationship  
shape\_aspect\_relationship.name = 'cross section dimensional aspect'}  
shape\_aspect\_relationship  
shape\_aspect\_relationship.related\_shape\_aspect ->  
shape\_aspect <-  
shape\_aspect\_relationship.relate\_shape\_aspect]  
[shape\_aspect\_relationship.relate\_shape\_aspect  
{shape\_aspect\_relationship  
shape\_aspect\_relationship.name = 'cross section dimensional aspect'}]

```

shape_aspect_relationship
shape_aspect_relationship.related_shape_aspect ->
shape_aspect <-
shape_aspect_relationship.related_shape_aspect]
shape_aspect_relationship =>
dimensional_location
dimensional_characteristic = dimensional_location
dimensional_characteristic <-
dimensional_characteristic_representation.dimension
dimensional_characteristic_representation
dimensional_characteristic_representation.representation ->
shape_dimension_representation <=
shape_representation <=
{representation
representation.name = 'hvac connector dimensional shape'}
representation
representation.items[i] ->
{representation_item
representation_item.name = 'equivalent length'}
representation_item =>
measure_representation_item <=
{measure_with_unit =>
length_measure_with_unit}
measure_with_unit
[measure_with_unit.value_component]
[measure_with_unit.unit_component]

```

#### 5.1.4.24 Hvac\_branch\_connection

AIM element: hvac\_branch\_connection

Source: 227

Reference path: hvac\_branch\_connection <=

```

shape_aspect_relationship
{shape_aspect_relationship
[shape_aspect_relationship.description = 'branch location']
[shape_aspect_relationship.relate_shape_aspect ->
shape_aspect
shape_aspect.of_shape ->
product_definition_shape <=
property_definition
property_definition.definition ->
characterized_definition
characterized_definition = characterized_product_definition
characterized_product_definition
characterized_product_definition = product_definition
product_definition =>
hvac_section_segment_definition]
[shape_aspect_relationship.related_shape_aspect ->
shape_aspect =>
hvac_section_segment_termination]]}

```

**5.1.4.24.1 branch\_sequence\_id**

AIM element: shape\_aspect\_relationship.name

Source: 41

Reference path: hvac\_branch\_connection <=  
 {shape\_aspect\_relationship  
 shape\_aspect\_relationship.relate\_shape\_aspect ->  
 shape\_aspect  
 shape\_aspect.of\_shape ->  
 product\_definition\_shape <-  
 [shape\_aspect.of\_shape  
 shape\_aspect  
 shape\_aspect.description = 'termination 1']  
 [shape\_aspect.of\_shape  
 shape\_aspect  
 shape\_aspect.description = 'termination 2']}  
 shape\_aspect\_relationship  
 shape\_aspect\_relationship.name

**5.1.4.25 Hvac\_plant\_item\_branch\_connector**

AIM element: hvac\_connector

Source: 227

Reference path: hvac\_connector <=  
 shape\_aspect  
 {shape\_aspect  
 shape\_aspect.description = 'hvac plant item branch connector'}

**5.1.4.25.1 hvac\_plant\_item\_branch\_connector to hvac\_plant\_item\_branch\_connection**

AIM element: PATH

Reference path: hvac\_connector <=  
 shape\_aspect <-  
 shape\_aspect\_relationship.related\_shape\_aspect  
 shape\_aspect\_relationship =>  
 hvac\_plant\_item\_branch\_connection

**5.1.4.26 Hvac\_plant\_item\_connector**

AIM element: hvac\_connector

Source: 227

Reference path: hvac\_connector <=  
 shape\_aspect  
 {shape\_aspect

```
shape_aspect.description = 'hvac plant item connector'}
```

#### 5.1.4.26.1 hvac\_plant\_item\_connector to hvac\_plant\_item\_connection

AIM element: PATH

Reference path: hvac\_connector <=  
 shape\_aspect <=  
 shape\_aspect\_relationship.related\_shape\_aspect  
 shape\_aspect\_relationship =>  
 hvac\_plant\_item\_connection

#### 5.1.4.27 Male\_end

AIM element: plant\_item\_connector

Source: 227

Reference path: plant\_item\_connector <=  
 shape\_aspect  
 {plant\_item\_connector  
 classification\_item = plant\_item\_connector  
 classification\_item <=  
 applied\_classification\_assignment.items[i]  
 applied\_classification\_assignment <=  
 classification\_assignment  
 classification\_assignment.assigned\_classification ->  
 [group =>  
 connector\_end\_type\_class]  
 [group  
 group.name = 'male end']]}

#### 5.1.4.27.1 inner\_end\_preparation

AIM element: descriptive\_representation\_item.description

Source: 45

Reference path: plant\_item\_connector <=  
 shape\_aspect  
 shape\_definition = shape\_aspect  
 shape\_definition  
 characterized\_definition = shape\_definition  
 characterized\_definition <=  
 property\_definition.definition  
 property\_definition  
 represented\_definition = property\_definition  
 represented\_definition <=  
 property\_definition\_representation.definition  
 property\_definition\_representation  
 property\_definition\_representation.used\_representation ->  
 representation  
 representation.items[i] ->

```

{representation_item
representation_item.name = 'inner end preparation'}
representation_item =>
descriptive_representation_item
descriptive_representation_item.description

```

#### 5.1.4.27.2 outer\_end\_preparation

AIM element: descriptive\_representation\_item.description

Source: 45

Reference path:

```

plant_item_connector <=
shape_aspect
shape_definition = shape_aspect
shape_definition
characterized_definition = shape_definition
characterized_definition <-
property_definition.definition
property_definition
represented_definition = property_definition
represented_definition <-
property_definition_representation.definition
property_definition_representation
property_definition_representation.used_representation ->
representation
representation.items[i] ->
{representation_item
representation_item.name = 'outer end preparation'}
representation_item =>
descriptive_representation_item
descriptive_representation_item.description

```

#### 5.1.4.28 Node

AIM element: plant\_item\_connector

Source: 227

Reference path:

```

plant_item_connector <=
shape_aspect
{shape_aspect
[shape_aspect.description = 'node']
[shape_aspect.of_shape ->
product_definition_shape <=
property_definition
property_definition.definition ->
characterized_definition
characterized_definition = characterized_product_definition
characterized_product_definition
characterized_product_definition = product_definition
product_definition
product_definition.frame_of_reference ->

```

```

product_definition_context <=
application_context_element
application_context_element.name = 'functional occurrence']]

```

#### 5.1.4.28.1 node to route

AIM element: PATH

Reference path:

```

plant_item_connector <=
shape_aspect
shape_aspect.of_shape ->
product_definition_shape <=
property_definition
property_definition.definition ->
characterized_definition
characterized_definition = characterized_product_definition
characterized_product_definition
characterized_product_definition = product_definition
product_definition <-
product_definition_relationship.related_product_definition
product_definition_relationship
product_definition_relationship.related_product_definition ->
product_definition
characterized_product_definition = product_definition
characterized_product_definition
characterized_definition = characterized_product_definition
characterized_definition <-
property_definition.definition
property_definition =>
product_definition_shape =>
plant_item_route

```

#### 5.1.4.29 Physical\_connector

AIM element: plant\_item\_connector

Source: 227

Reference path:

```

plant_item_connector <=
shape_aspect
{ shape_aspect
shape_aspect.of_shape ->
product_definition_shape <=
property_definition
property_definition.definition ->
characterized_definition
characterized_definition = characterized_product_definition
characterized_product_definition
characterized_product_definition = product_definition
product_definition
product_definition.frame_of_reference ->
product_definition_context <=
application_context_element

```

```
application_context_element.name = 'physical occurrence'}
```

#### 5.1.4.29.1 **physical\_connector to functional\_connector\_occurrence\_satisfaction**

AIM element: PATH

Reference path: 

```
plant_item_connector <=
shape_aspect <-
shape_aspect_relationship.related_shape_aspect
{ shape_aspect_relationship
shape_aspect_relationship.name = 'connector occurrence satisfaction'}
```

#### 5.1.4.30 **Piping\_connector**

AIM element: plant\_item\_connector

Source: 227

Reference path: 

```
plant_item_connector <=
shape_aspect
{ plant_item_connector
classification_item = plant_item_connector
classification_item <-
applied_classification_assignment.items[i]
applied_classification_assignment <=
classification_assignment
classification_assignment.assigned_classification ->
group =>
piping_connector_class}
{ (plant_item_connector)
(plant_item_connector
classification_item = plant_item_connector
classification_item <-
applied_classification_assignment.items[i]
applied_classification_assignment <=
classification_assignment
classification_assignment.assigned_classification ->
group =>
connector_end_type_class)}
```

#### 5.1.4.30.1 **connector\_flow\_direction**

AIM element: descriptive\_representation\_item.description

Source: 45

Reference path: 

```
plant_item_connector <=
shape_aspect
shape_definition = shape_aspect
shape_definition
characterized_definition = shape_definition
```

```

characterized_definition <-
property_definition.definition
property_definition
represented_definition = property_definition
represented_definition <-
property_definition_representation.definition
property_definition_representation
property_definition_representation.used_representation ->
representation
representation.items[i] ->
{representation_item
representation_item.name = 'flow direction'}
representation_item =>
descriptive_representation_item
descriptive_representation_item.description

```

### 5.1.4.30.2 connector\_specifications

AIM element: document\_usage\_constraint.subject\_element\_value

Source: 41

Reference path: plant\_item\_connector  
document\_item = plant\_item\_connector  
document\_item <-  
applied\_document\_reference.items[i]  
applied\_document\_reference <=  
document\_reference  
document\_reference.assigned\_document ->  
{document  
document.kind ->  
document\_type  
document\_type.product\_data\_type = 'connector specification'}  
document <-  
document\_usage\_constraint.source  
document\_usage\_constraint  
document\_usage\_constraint.subject\_element\_value

### 5.1.4.30.3 name

AIM element: shape\_aspect.description

Source: 41

Reference path: plant\_item\_connector <=  
shape\_aspect  
shape\_aspect.description

### 5.1.4.30.4 piping\_connector to piping\_connector\_service\_characteristic

AIM element: PATH

Reference path:     plant\_item\_connector <=  
                           shape\_aspect  
                           shape\_definition = shape\_aspect  
                           shape\_definition  
                           characterized\_definition = shape\_definition  
                           characterized\_definition <=  
                           property\_definition.definition  
                           {property\_definition  
                           property\_definition.name = 'service characteristics'}  
                           property\_definition

#### **5.1.4.30.5     piping\_connector to piping\_size\_description**

AIM element:        PATH

Reference path:     plant\_item\_connector <=  
                           shape\_aspect <=  
                           dimensional\_size.applies\_to  
                           dimensional\_size  
                           dimensional\_characteristic = dimensional\_size  
                           dimensional\_characteristic <=  
                           dimensional\_characteristic\_representation.dimension  
                           dimensional\_characteristic\_representation  
                           dimensional\_characteristic\_representation.representation ->  
                           shape\_dimension\_representation

#### **5.1.4.31     Piping\_connector\_service\_characteristic**

AIM element:        property\_definition

Source:             41

Reference path:     {property\_definition  
                           property\_definition.name = 'service characteristics'}

##### **5.1.4.31.1     design\_pressure**

AIM element:        [measure\_with\_unit.value\_component]  
                           [measure\_with\_unit.unit\_component]

Source:             41

Reference path:     property\_definition  
                           represented\_definition = property\_definition  
                           represented\_definition <=  
                           property\_definition\_representation.definition  
                           property\_definition\_representation  
                           property\_definition\_representation.used\_representation ->  
                           {representation  
                           representation.name = 'design service characteristics'}  
                           representation  
                           (representation.items[i] ->  
                           {representation\_item

```

(representation_item.name = 'pressure')
(representation_item.name = 'maximum pressure')
(representation_item.name = 'minimum pressure'))
([representation.items[i] ->
 {representation_item
 representation_item.name = 'maximum pressure'}}
 [representation.items[i] ->
 {representation_item
 representation_item.name = 'minimum pressure'}}])
representation_item =>
measure_representation_item <=
measure_with_unit
[{measure_with_unit.value_component ->
measure_value
measure_value = ratio_measure}
measure_with_unit.value_component]
[{measure_with_unit.unit_component ->
unit
unit = derived_unit}
measure_with_unit.unit_component]

```

### 5.1.4.31.2 design\_temperature

AIM element: [measure\_with\_unit.value\_component]  
[measure\_with\_unit.unit\_component]

Source: 41

Reference path: property\_definition  
represented\_definition = property\_definition  
represented\_definition <-  
property\_definition\_representation.definition  
property\_definition\_representation  
property\_definition\_representation.used\_representation ->  
{representation  
representation.name = 'design service characteristics'}  
representation  
(representation.items[i] ->  
{representation\_item  
(representation\_item.name = 'temperature')  
(representation\_item.name = 'maximum temperature')  
(representation\_item.name = 'minimum temperature'))})  
([representation.items[i] ->  
{representation\_item  
representation\_item.name = 'maximum temperature'}}]  
[representation.items[i] ->  
{representation\_item  
representation\_item.name = 'minimum temperature'}}])  
representation\_item =>  
measure\_representation\_item <=  
{measure\_with\_unit =>  
thermodynamic\_temperature\_measure\_with\_unit}  
measure\_with\_unit

```
[measure_with_unit.value_component]
[measure_with_unit.unit_component]
```

### 5.1.4.31.3 **piping\_connector\_service\_characteristic to service\_operating\_case**

AIM element: PATH

Reference path: `property_definition <-  
property_definition_relationship.related_property_definition  
property_definition_relationship`

### 5.1.4.32 **Plant\_item\_connector**

AIM element: plant\_item\_connector

Source: 227

Reference path: `plant_item_connector <=  
shape_aspect  
{shape_aspect  
shape_aspect.product_definitional = TRUE}`

#### 5.1.4.32.1 **connect\_point**

AIM element: cartesian\_point

Source: 42

Reference path: `plant_item_connector <=  
shape_aspect  
shape_definition = shape_aspect  
shape_definition  
characterized_definition = shape_definition  
characterized_definition <-  
property_definition.definition  
property_definition  
represented_definition = property_definition  
represented_definition <-  
property_definition_representation.definition  
property_definition_representation  
property_definition_representation.used_representation ->  
representation  
representation.items[i] ->  
{representation_item  
representation_item.name = 'connect point'}  
representation_item =>  
geometric_representation_item =>  
point =>  
cartesian_point`

**5.1.4.32.2 plant\_item\_connector\_id**

AIM element: shape\_aspect.name

Source: 41

Reference path: plant\_item\_connector <=  
 shape\_aspect  
 shape\_aspect.name

**5.1.4.32.3 plant\_item\_connector to changed\_plant\_item\_connector**

AIM element: IDENTICAL MAPPING

**5.1.4.32.4 plant\_item\_connector to external\_classification**

AIM element: PATH

Reference path: plant\_item\_connector  
 classification\_item = plant\_item\_connector  
 classification\_item <-  
 applied\_classification\_assignment.items[i]  
 applied\_classification\_assignment <=  
 classification\_assignment  
 classification\_assignment.assigned\_classification ->  
 group =>  
 externally\_defined\_class

**5.1.4.32.5 plant\_item\_connector to required\_material\_description**

AIM element: PATH

Reference path: plant\_item\_connector <=  
 shape\_aspect  
 shape\_definition = shape\_aspect  
 shape\_definition  
 characterized\_definition = shape\_definition  
 characterized\_definition <-  
 property\_definition.definition  
 {property\_definition =>  
 material\_property =>  
 required\_material\_property}  
 property\_definition <-  
 property\_definition\_relationship.related\_property\_definition  
 {property\_definition\_relationship  
 property\_definition\_relationship.name = 'requirement allocation'}  
 property\_definition\_relationship  
 property\_definition\_relationship.relying\_property\_definition ->  
 {property\_definition =>  
 material\_property}  
 property\_definition  
 property\_definition.definition ->

```

characterized_definition
characterized_definition = characterized_product_definition
characterized_product_definition
characterized_product_definition = product_definition
product_definition

```

#### 5.1.4.32.6 **plant\_item\_connector to shape\_representation**

AIM element: PATH

Rules: subtype\_mandatory\_shape\_representation

Reference path: plant\_item\_connector <=  
 shape\_aspect  
 represented\_definition = shape\_aspect  
 represented\_definition <=  
 property\_definition\_representation.definition  
 property\_definition\_representation  
 property\_definition\_representation.used\_representation ->  
 representation =>  
 shape\_representation =>  
 (plant\_csg\_shape\_representation)  
 (hybrid\_shape\_representation)

#### 5.1.4.32.7 **plant\_item\_connector to shape\_inspection\_record**

AIM element: PATH

Reference path: plant\_item\_connector <=  
 shape\_aspect  
 shape\_definition = shape\_aspect  
 characterized\_definition = shape\_definition  
 characterized\_definition <=  
 property\_definition.definition  
 property\_definition =>  
 {property\_definition.description = 'shape inspection record'}  
 material\_property

#### 5.1.4.32.8 **plant\_item\_connector to piping\_component\_inspection\_record**

AIM element: PATH

Reference path: plant\_item\_connector <=  
 shape\_aspect  
 shape\_definition = shape\_aspect  
 characterized\_definition = shape\_definition  
 characterized\_definition <=  
 property\_definition.definition  
 property\_definition =>  
 {property\_definition.description = 'piping component inspection record'}  
 material\_property

### 5.1.4.33 Plant\_item\_connector\_occurrence

AIM element: plant\_item\_connector

Source: 227

Reference path: plant\_item\_connector <=  
 shape\_aspect  
 { shape\_aspect  
 shape\_aspect.of\_shape ->  
 product\_definition\_shape <=  
 property\_definition  
 property\_definition.definition ->  
 characterized\_definition  
 characterized\_definition = characterized\_product\_definition  
 characterized\_product\_definition  
 characterized\_product\_definition = product\_definition  
 product\_definition  
 product\_definition.frame\_of\_reference ->  
 product\_definition\_context <=  
 application\_context\_element  
 (application\_context\_element.name = 'functional occurrence')  
 (application\_context\_element.name = 'physical occurrence')}

#### 5.1.4.33.1 orientation

AIM element: (axis2\_placement\_2d)  
 (axis2\_placement\_3d)

Source: 42

Reference path: plant\_item\_connector <=  
 shape\_aspect  
 represented\_definition = shape\_aspect  
 represented\_definition <=  
 property\_definition\_representation.definition  
 property\_definition\_representation  
 property\_definition\_representation.used\_representation ->  
 representation  
 representation.items[i] ->  
 { representation\_item  
 representation\_item.name = 'connector orientation'  
 representation\_item =>  
 geometric\_representation\_item =>  
 { placement  
 placement.location ->  
 cartesian\_point <=  
 point <=  
 geometric\_representation\_item <=  
 representation\_item  
 representation\_item.name = 'connect point'  
 placement =>  
 (axis2\_placement\_2d)

(axis2\_placement\_3d)

**5.1.4.34 Pressure\_fit**

AIM element: plant\_item\_connector

Source: 227

Reference path: plant\_item\_connector <=  
 shape\_aspect  
 {plant\_item\_connector  
 classification\_item = plant\_item\_connector  
 classification\_item <=  
 applied\_classification\_assignment.items[i]  
 applied\_classification\_assignment <=  
 classification\_assignment  
 classification\_assignment.assigned\_classification ->  
 [group =>  
 piping\_connector\_class]  
 [group  
 group.name = 'pressure fit']}

**5.1.4.35 Service\_operating\_case**

AIM element: property\_definition\_relationship

Source: 45

Reference path: {property\_definition\_relationship  
 [property\_definition\_relationship.relateing\_property\_definition ->  
 property\_definition =>  
 stream\_design\_case]  
 [property\_definition\_relationship.related\_property\_definition ->  
 property\_definition  
 property\_definition.name = 'service characteristics']}

**5.1.4.35.1 duration**

AIM element: [measure\_with\_unit.value\_component]  
 [measure\_with\_unit.unit\_component]

Source: 41

Reference path: property\_definition\_relationship  
 property\_definition\_relationship.related\_property\_definition ->  
 property\_definition  
 represented\_definition = property\_definition  
 represented\_definition <=  
 property\_definition\_representation.definition  
 property\_definition\_representation  
 property\_definition\_representation.used\_representation ->  
 {representation  
 representation.name = 'service operating characteristics'}

```

representation
(representation.items[i] ->
{representation_item
(representation_item.name = 'duration')
(representation_item.name = 'maximum duration')
(representation_item.name = 'minimum duration'))})
([representation.items[i] ->
{representation_item
representation_item.name = 'maximum duration'}}]
[representation.items[i] ->
{representation_item
representation_item.name = 'minimum duration'}}])
representation_item =>
measure_representation_item <=
{measure_with_unit =>
time_measure_with_unit}
measure_with_unit
[measure_with_unit.value_component]
[measure_with_unit.unit_component]

```

### 5.1.4.35.2 frequency

AIM element: [measure\_with\_unit.value\_component]  
[measure\_with\_unit.unit\_component]

Source: 41

Reference path: property\_definition\_relationship  
property\_definition\_relationship.related\_property\_definition ->  
property\_definition  
represented\_definition = property\_definition  
represented\_definition <-  
property\_definition\_representation.definition  
property\_definition\_representation  
property\_definition\_representation.used\_representation ->  
{representation  
representation.name = 'service operating characteristics'}  
representation  
(representation.items[i] ->  
{representation\_item  
(representation\_item.name = 'frequency')  
(representation\_item.name = 'maximum frequency')  
(representation\_item.name = 'minimum frequency'))})  
([representation.items[i] ->  
{representation\_item  
representation\_item.name = 'maximum frequency'}}]  
[representation.items[i] ->  
{representation\_item  
representation\_item.name = 'minimum frequency'}}])  
representation\_item =>  
measure\_representation\_item <=  
measure\_with\_unit  
[measure\_with\_unit.value\_component]

[measure\_with\_unit.unit\_component]

### 5.1.4.35.3 **name**

AIM element: property\_definition\_relationship.description

Source: 45

### 5.1.4.35.4 **operating\_case\_id**

AIM element: property\_definition\_relationship.name

Source: 45

### 5.1.4.35.5 **operating\_pressure**

AIM element: [measure\_with\_unit.value\_component]  
[measure\_with\_unit.unit\_component]

Source: 41

Reference path: property\_definition\_relationship  
property\_definition\_relationship.related\_property\_definition ->  
property\_definition  
represented\_definition = property\_definition  
represented\_definition <-  
property\_definition\_representation.definition  
property\_definition\_representation  
property\_definition\_representation.used\_representation ->  
{representation  
representation.name = 'service operating characteristics'}  
representation  
(representation.items[i] ->  
{representation\_item  
(representation\_item.name = 'pressure')  
(representation\_item.name = 'maximum pressure')  
(representation\_item.name = 'minimum pressure'}})  
([representation.items[i] ->  
{representation\_item  
representation\_item.name = 'maximum pressure'}}]  
[representation.items[i] ->  
{representation\_item  
representation\_item.name = 'minimum pressure'}}]  
representation\_item =>  
measure\_representation\_item <=  
measure\_with\_unit  
[{measure\_with\_unit.value\_component ->  
measure\_value  
measure\_value = ratio\_measure}  
measure\_with\_unit.value\_component]  
[{measure\_with\_unit.unit\_component ->  
unit

```

unit = derived_unit}
measure_with_unit.unit_component]

```

### 5.1.4.35.6 operating\_temperature

AIM element: [measure\_with\_unit.value\_component]  
[measure\_with\_unit.unit\_component]

Source: 41

Reference path: property\_definition\_relationship  
property\_definition\_relationship.related\_property\_definition ->  
property\_definition  
represented\_definition = property\_definition  
represented\_definition <-  
property\_definition\_representation.definition  
property\_definition\_representation  
property\_definition\_representation.used\_representation ->  
{representation  
representation.name = 'service operating characteristics'}  
representation  
(representation.items[i] ->  
{representation\_item  
(representation\_item.name = 'temperature')  
(representation\_item.name = 'maximum temperature')  
(representation\_item.name = 'minimum temperature'}})  
([representation.items[i] ->  
{representation\_item  
representation\_item.name = 'maximum temperature'}}]  
[representation.items[i] ->  
{representation\_item  
representation\_item.name = 'minimum duration'}}])  
representation\_item =>  
measure\_representation\_item <=  
{measure\_with\_unit =>  
thermodynamic\_temperature\_measure\_with\_unit}  
measure\_with\_unit  
[measure\_with\_unit.value\_component]  
[measure\_with\_unit.unit\_component]

### 5.1.4.36 Socket

AIM element: plant\_item\_connector

Source: 227

Reference path: plant\_item\_connector <=  
shape\_aspect  
{plant\_item\_connector  
classification\_item = plant\_item\_connector  
classification\_item <-  
applied\_classification\_assignment.items[i]  
applied\_classification\_assignment <=

```

classification_assignment
classification_assignment.assigned_classification ->
[group =>
piping_connector_class]
[group
group.name = 'socket']]

```

### 5.1.4.36.1 set\_back

AIM element: [measure\_with\_unit.value\_component]  
[measure\_with\_unit.unit\_component]

Source: 41

Rules: subtype\_mandatory\_shape\_representation

Reference path:

```

plant_item_connector <=
shape_aspect <-
[shape_aspect_relationship.relate_shape_aspect
{shape_aspect_relationship
shape_aspect_relationship.name = 'connector dimensional aspect'}
shape_aspect_relationship
shape_aspect_relationship.related_shape_aspect ->
shape_aspect <-
shape_aspect_relationship.relate_shape_aspect]
[shape_aspect_relationship.relate_shape_aspect
{shape_aspect_relationship
shape_aspect_relationship.name = 'connector dimensional aspect'}
shape_aspect_relationship
shape_aspect_relationship.related_shape_aspect ->
shape_aspect <-
shape_aspect_relationship.related_shape_aspect]
shape_aspect_relationship =>
dimensional_location
dimensional_characteristic = dimensional_location
dimensional_characteristic <-
dimensional_characteristic_representation.dimension
dimensional_characteristic_representation
dimensional_characteristic_representation.representation ->
shape_dimension_representation <=
shape_representation <=
{representation
representation.name = 'piping connector dimensional shape'}
representation
representation.items[i] ->
{representation_item
representation_item.name = 'set back'}
representation_item =>
measure_representation_item <=
{measure_with_unit =>
length_measure_with_unit}
measure_with_unit
[measure_with_unit.value_component]

```

[measure\_with\_unit.unit\_component]

### 5.1.4.37 Structural\_load\_connector

AIM element: plant\_item\_connector

Source: 227

Reference path: plant\_item\_connector <=  
 shape\_aspect  
 {plant\_item\_connector  
 classification\_item = plant\_item\_connector  
 classification\_item <=  
 applied\_classification\_assignment.items[i]  
 applied\_classification\_assignment <=  
 {classification\_assignment  
 classification\_assignment.role ->  
 classification\_role  
 classification\_role.name = 'structural connector type classification'}  
 classification\_assignment  
 classification\_assignment.assigned\_classification ->  
 group =>  
 structural\_load\_connector\_class}

#### 5.1.4.37.1 type

AIM element: group.name

Source: 41

Reference path: plant\_item\_connector  
 classification\_item = plant\_item\_connector  
 classification\_item <=  
 applied\_classification\_assignment.items[i]  
 applied\_classification\_assignment <=  
 {classification\_assignment  
 classification\_assignment.role ->  
 classification\_role  
 classification\_role.name = 'structural connector type classification'}  
 classification\_assignment  
 classification\_assignment.assigned\_classification ->  
 {group =>  
 structural\_load\_connector\_class}  
 group  
 group.name

### 5.1.4.38 Stub\_in

AIM element: plant\_item\_connector

Source: 227

Reference path: `plant_item_connector <=`  
`shape_aspect`  
`{plant_item_connector`  
`classification_item = plant_item_connector`  
`classification_item <-`  
`applied_classification_assignment.items[i]`  
`applied_classification_assignment <=`  
`classification_assignment`  
`classification_assignment.assigned_classification ->`  
`[group =>`  
`piping_connector_class]`  
`[group`  
`group.name = 'stub in'] }`

### 5.1.4.38.1 stub\_in\_depth

AIM element: `[measure_with_unit.value_component]`  
`[measure_with_unit.unit_component]`

Source: 41

Rules: `subtype_mandatory_shape_representation`

Reference path: `plant_item_connector <=`  
`shape_aspect <-`  
`[shape_aspect_relationship.relying_shape_aspect`  
`{shape_aspect_relationship`  
`shape_aspect_relationship.name = 'connector dimensional aspect'}`  
`shape_aspect_relationship`  
`shape_aspect_relationship.related_shape_aspect ->`  
`shape_aspect <-`  
`shape_aspect_relationship.relying_shape_aspect]`  
`[shape_aspect_relationship.relying_shape_aspect`  
`{shape_aspect_relationship`  
`shape_aspect_relationship.name = 'connector dimensional aspect'}`  
`shape_aspect_relationship`  
`shape_aspect_relationship.related_shape_aspect ->`  
`shape_aspect <-`  
`shape_aspect_relationship.related_shape_aspect]`  
`shape_aspect_relationship =>`  
`dimensional_location`  
`dimensional_characteristic = dimensional_location`  
`dimensional_characteristic <-`  
`dimensional_characteristic_representation.dimension`  
`dimensional_characteristic_representation`  
`dimensional_characteristic_representation.representation ->`  
`shape_dimension_representation <=`  
`shape_representation <=`  
`{representation`  
`representation.name = 'piping connector dimensional shape'}`  
`representation`  
`representation.items[i] ->`  
`{representation_item`  
`representation_item.name = 'stub in depth'}`

```

representation_item =>
measure_representation_item <=
{measure_with_unit =>
length_measure_with_unit}
measure_with_unit
[measure_with_unit.value_component]
[measure_with_unit.unit_component]

```

### 5.1.4.39 Threaded

AIM element: plant\_item\_connector

Source: 227

Reference path: plant\_item\_connector <=

```

shape_aspect
{plant_item_connector
classification_item = plant_item_connector
classification_item <-
applied_classification_assignment.items[i]
applied_classification_assignment <=
classification_assignment
classification_assignment.assigned_classification ->
[group =>
piping_connector_class]
[group
group.name = 'threaded']}]

```

#### 5.1.4.39.1 thread\_engagement\_depth

AIM element: [measure\_with\_unit.value\_component]  
[measure\_with\_unit.unit\_component]

Source: 41

Rules: subtype\_mandatory\_shape\_representation

Reference path: plant\_item\_connector <=

```

shape_aspect <-
[shape_aspect_relationship.relying_shape_aspect
{shape_aspect_relationship
shape_aspect_relationship.name = 'connector dimensional aspect'}
shape_aspect_relationship
shape_aspect_relationship.related_shape_aspect ->
shape_aspect <-
shape_aspect_relationship.relying_shape_aspect]
[shape_aspect_relationship.relying_shape_aspect
{shape_aspect_relationship
shape_aspect_relationship.name = 'connector dimensional aspect'}
shape_aspect_relationship
shape_aspect_relationship.related_shape_aspect ->
shape_aspect <-
shape_aspect_relationship.related_shape_aspect]

```

```

shape_aspect_relationship =>
dimensional_location
dimensional_characteristic = dimensional_location
dimensional_characteristic <-
dimensional_characteristic_representation.dimensional_location
dimensional_characteristic_representation
dimensional_characteristic_representation.representation ->
shape_dimension_representation <=
shape_representation <=
{representation
representation.name = 'piping connector dimensional shape'}
representation
representation.items[i] ->
{representation_item
representation_item.name = 'thread engagement depth'}
representation_item =>
measure_representation_item <=
{measure_with_unit =>
length_measure_with_unit}
measure_with_unit
[measure_with_unit.value_component]
[measure_with_unit.unit_component]

```

## 5.1.5 HVAC\_component\_characterizationUoF

### 5.1.5.1 Cross\_section\_flat\_oval

AIM element: hvac\_cross\_section

Source: 227

Reference path: hvac\_cross\_section <=
 shape\_aspect
 {shape\_aspect.description = 'flat oval'}

#### 5.1.5.1.1 height

AIM element: [measure\_with\_unit.value\_component]
 [measure\_with\_unit.unit\_component]

Source: 41

Rules: subtype\_mandatory\_shape\_representation

Reference path: hvac\_cross\_section <=
 shape\_aspect <-
 [shape\_aspect\_relationship.relate\_shape\_aspect
 {shape\_aspect\_relationship
 shape\_aspect\_relationship.name = 'cross section dimensional aspect'}
 shape\_aspect\_relationship
 shape\_aspect\_relationship.related\_shape\_aspect ->
 shape\_aspect <-
 shape\_aspect\_relationship.relate\_shape\_aspect]

```

[shape_aspect_relationship.relating_shape_aspect
{shape_aspect_relationship
shape_aspect_relationship.name = 'cross section dimensional aspect'}
shape_aspect_relationship
shape_aspect_relationship.related_shape_aspect ->
shape_aspect <-
shape_aspect_relationship.related_shape_aspect]
shape_aspect_relationship =>
dimensional_location
dimensional_characteristic = dimensional_location
dimensional_characteristic <-
dimensional_characteristic_representation.dimension
dimensional_characteristic_representation
dimensional_characteristic_representation.representation ->
shape_dimension_representation <=
shape_representation <=
{representation
representation.name = 'hvac connector dimensional shape'}
representation
representation.items[i] ->
{representation_item
representation_item.name = 'height'}
representation_item =>
measure_representation_item <=
{measure_with_unit =>
length_measure_with_unit}
measure_with_unit
[measure_with_unit.value_component]
[measure_with_unit.unit_component]

```

### 5.1.5.1.2 width

AIM element: [measure\_with\_unit.value\_component]  
[measure\_with\_unit.unit\_component]

Source: 41

Reference path: hvac\_cross\_section <=

```

shape_aspect <-
[shape_aspect_relationship.relating_shape_aspect
{shape_aspect_relationship
shape_aspect_relationship.name = 'cross section dimensional aspect'}
shape_aspect_relationship
shape_aspect_relationship.related_shape_aspect ->
shape_aspect <-
shape_aspect_relationship.relating_shape_aspect]
[shape_aspect_relationship.relating_shape_aspect
{shape_aspect_relationship
shape_aspect_relationship.name = 'cross section dimensional aspect'}
shape_aspect_relationship
shape_aspect_relationship.related_shape_aspect ->
shape_aspect <-
shape_aspect_relationship.related_shape_aspect]
shape_aspect_relationship =>

```

```

dimensional_location
dimensional_characteristic = dimensional_location
dimensional_characteristic <-
dimensional_characteristic_representation.dimension
dimensional_characteristic_representation
dimensional_characteristic_representation.representation ->
shape_dimension_representation <=
shape_representation <=
{representation
representation.name = 'hvac connector dimensional shape'}
representation
representation.items[i] ->
{representation_item
representation_item.name = 'width'}
representation_item =>
measure_representation_item <=
{measure_with_unit =>
length_measure_with_unit}
measure_with_unit
[measure_with_unit.value_component]
[measure_with_unit.unit_component]

```

### 5.1.5.2 Cross\_section\_non\_standard

AIM element: hvac\_cross\_section

Source: 227

Reference path: hvac\_cross\_section <=
 shape\_aspect
 {shape\_aspect.description = 'non standard'}

#### 5.1.5.2.1 closed\_bounded\_curve

AIM element: curve

Source: 42

Reference path: hvac\_cross\_section <=
 shape\_aspect
 shape\_definition = shape\_aspect
 shape\_definition
 characterized\_definition = shape\_definition
 characterized\_definition <-
 property\_definition.definition
 property\_definition
 represented\_definition = property\_definition
 represented\_definition <-
 property\_definition\_representation.definition
 property\_definition\_representation
 property\_definition\_representation.used\_representation ->
 representation
 {representation.name = 'cross section representation'}

```

representation.items[i] ->
representation_item
{representation_item.name = 'closed bounded curve'}
representation_item =>
geometric_representation_item =>
curve

```

### 5.1.5.3 Cross\_section\_radiused\_corner

AIM element: hvac\_cross\_section

Source: 227

Reference path: hvac\_cross\_section <=  
 shape\_aspect  
 {shape\_aspect.description = 'radiused corner'}

#### 5.1.5.3.1 height

AIM element: [measure\_with\_unit.value\_component]  
 [measure\_with\_unit.unit\_component]

Source: 41

Rules: subtype\_mandatory\_shape\_representation

Reference path: hvac\_cross\_section <=  
 shape\_aspect <-  
 [shape\_aspect\_relationship.relate\_shape\_aspect  
 {shape\_aspect\_relationship  
 shape\_aspect\_relationship.name = 'cross section dimensional aspect'}  
 shape\_aspect\_relationship  
 shape\_aspect\_relationship.related\_shape\_aspect ->  
 shape\_aspect <-  
 shape\_aspect\_relationship.relate\_shape\_aspect]  
 [shape\_aspect\_relationship.relate\_shape\_aspect  
 {shape\_aspect\_relationship  
 shape\_aspect\_relationship.name = 'cross section dimensional aspect'}  
 shape\_aspect\_relationship  
 shape\_aspect\_relationship.related\_shape\_aspect ->  
 shape\_aspect <-  
 shape\_aspect\_relationship.related\_shape\_aspect]  
 shape\_aspect\_relationship =>  
 dimensional\_location  
 dimensional\_characteristic = dimensional\_location  
 dimensional\_characteristic <-  
 dimensional\_characteristic\_representation.dimension  
 dimensional\_characteristic\_representation  
 dimensional\_characteristic\_representation.representation ->  
 shape\_dimension\_representation <=  
 shape\_representation <=  
 {representation  
 representation.name = 'hvac connector dimensional shape'}

```

representation
representation.items[i] ->
{representation_item
representation_item.name = 'height'}
representation_item =>
measure_representation_item <=
{measure_with_unit =>
length_measure_with_unit}
measure_with_unit
[measure_with_unit.value_component]
[measure_with_unit.unit_component]

```

### 5.1.5.3.2 width

AIM element: [measure\_with\_unit.value\_component]  
[measure\_with\_unit.unit\_component]

Source: 41

Rules: subtype\_mandatory\_shape\_representation

Reference path: hvac\_cross\_section <=

```

shape_aspect <-
[shape_aspect_relationship.relate_shape_aspect
{shape_aspect_relationship
shape_aspect_relationship.name = 'cross section dimensional aspect'}
shape_aspect_relationship
shape_aspect_relationship.related_shape_aspect ->
shape_aspect <-
shape_aspect_relationship.relate_shape_aspect]
[shape_aspect_relationship.relate_shape_aspect
{shape_aspect_relationship
shape_aspect_relationship.name = 'cross section dimensional aspect'}
shape_aspect_relationship
shape_aspect_relationship.related_shape_aspect ->
shape_aspect <-
shape_aspect_relationship.related_shape_aspect]
shape_aspect_relationship =>
dimensional_location
dimensional_characteristic = dimensional_location
dimensional_characteristic <-
dimensional_characteristic_representation.dimensional_location
dimensional_characteristic_representation
dimensional_characteristic_representation.representation ->
shape_dimension_representation <=
shape_representation <=
{representation
representation.name = 'hvac connector dimensional shape'}
representation
representation.items[i] ->
{representation_item
representation_item.name = 'width'}
representation_item =>
measure_representation_item <=

```

```

{measure_with_unit =>
length_measure_with_unit}
measure_with_unit
[measure_with_unit.value_component]
[measure_with_unit.unit_component]

```

### 5.1.5.3.3 corner\_radius

AIM element: [measure\_with\_unit.value\_component]  
[measure\_with\_unit.unit\_component]

Source: 41

Rules: subtype\_mandatory\_shape\_representation

Reference path: hvac\_cross\_section <=  
 shape\_aspect <-  
 [shape\_aspect\_relationship.relate\_shape\_aspect  
 {shape\_aspect\_relationship  
 shape\_aspect\_relationship.name = 'cross section dimensional aspect'}  
 shape\_aspect\_relationship  
 shape\_aspect\_relationship.related\_shape\_aspect ->  
 shape\_aspect <-  
 shape\_aspect\_relationship.relate\_shape\_aspect]  
 [shape\_aspect\_relationship.relate\_shape\_aspect  
 {shape\_aspect\_relationship  
 shape\_aspect\_relationship.name = 'cross section dimensional aspect'}  
 shape\_aspect\_relationship  
 shape\_aspect\_relationship.related\_shape\_aspect ->  
 shape\_aspect <-  
 shape\_aspect\_relationship.related\_shape\_aspect]  
 shape\_aspect\_relationship =>  
 dimensional\_location  
 dimensional\_characteristic = dimensional\_location  
 dimensional\_characteristic <-  
 dimensional\_characteristic\_representation.dimension  
 dimensional\_characteristic\_representation  
 dimensional\_characteristic\_representation.representation ->  
 shape\_dimension\_representation <=  
 shape\_representation <=  
 {representation  
 representation.name = 'hvac connector dimensional shape'}  
 representation  
 representation.items[i] ->  
 {representation\_item  
 representation\_item.name = 'corner radius'}  
 representation\_item =>  
 measure\_representation\_item <=  
 {measure\_with\_unit =>  
 length\_measure\_with\_unit}  
 measure\_with\_unit  
 [measure\_with\_unit.value\_component]  
 [measure\_with\_unit.unit\_component]

### 5.1.5.4 Cross\_section\_rectangular

AIM element: hvac\_cross\_section

Source: 227

Reference path: hvac\_cross\_section <=  
 shape\_aspect  
 {shape\_aspect.description = 'rectangular'}

#### 5.1.5.4.1 height

AIM element: [measure\_with\_unit.value\_component]  
 [measure\_with\_unit.unit\_component]

Source: 41

Rules: subtype\_mandatory\_shape\_representation

Reference path: hvac\_cross\_section <=  
 shape\_aspect <-  
 [shape\_aspect\_relationship.relate\_shape\_aspect  
 {shape\_aspect\_relationship  
 shape\_aspect\_relationship.name = 'cross section dimensional aspect'}  
 shape\_aspect\_relationship  
 shape\_aspect\_relationship.related\_shape\_aspect ->  
 shape\_aspect <-  
 shape\_aspect\_relationship.relate\_shape\_aspect]  
 [shape\_aspect\_relationship.relate\_shape\_aspect  
 {shape\_aspect\_relationship  
 shape\_aspect\_relationship.name = 'cross section dimensional aspect'}  
 shape\_aspect\_relationship  
 shape\_aspect\_relationship.related\_shape\_aspect ->  
 shape\_aspect <-  
 shape\_aspect\_relationship.related\_shape\_aspect]  
 shape\_aspect\_relationship =>  
 dimensional\_location  
 dimensional\_characteristic = dimensional\_location  
 dimensional\_characteristic <-  
 dimensional\_characteristic\_representation.dimension  
 dimensional\_characteristic\_representation  
 dimensional\_characteristic\_representation.representation ->  
 shape\_dimension\_representation <=  
 shape\_representation <=  
 {representation  
 representation.name = 'hvac connector dimensional shape'}  
 representation  
 representation.items[i] ->  
 {representation\_item  
 representation\_item.name = 'height'}  
 representation\_item =>  
 measure\_representation\_item <=  
 {measure\_with\_unit =>  
 length\_measure\_with\_unit}

```

measure_with_unit
[measure_with_unit.value_component]
[measure_with_unit.unit_component]

```

#### 5.1.5.4.2 width

AIM element: [measure\_with\_unit.value\_component]  
[measure\_with\_unit.unit\_component]

Source: 41

Rules: subtype\_mandatory\_shape\_representation

Reference path: hvac\_cross\_section <=  
 shape\_aspect <-  
 [shape\_aspect\_relationship.relate\_shape\_aspect  
 {shape\_aspect\_relationship  
 shape\_aspect\_relationship.name = 'cross section dimensional aspect'}  
 shape\_aspect\_relationship  
 shape\_aspect\_relationship.related\_shape\_aspect ->  
 shape\_aspect <-  
 shape\_aspect\_relationship.relate\_shape\_aspect]  
 [shape\_aspect\_relationship.relate\_shape\_aspect  
 {shape\_aspect\_relationship  
 shape\_aspect\_relationship.name = 'cross section dimensional aspect'}  
 shape\_aspect\_relationship  
 shape\_aspect\_relationship.related\_shape\_aspect ->  
 shape\_aspect <-  
 shape\_aspect\_relationship.related\_shape\_aspect]  
 shape\_aspect\_relationship =>  
 dimensional\_location  
 dimensional\_characteristic = dimensional\_location  
 dimensional\_characteristic <-  
 dimensional\_characteristic\_representation.dimension  
 dimensional\_characteristic\_representation  
 dimensional\_characteristic\_representation.representation ->  
 shape\_dimension\_representation <=  
 shape\_representation <=  
 {representation  
 representation.name = 'hvac connector dimensional shape'}  
 representation  
 representation.items[i] ->  
 {representation\_item  
 representation\_item.name = 'width'}  
 representation\_item =>  
 measure\_representation\_item <=  
 {measure\_with\_unit =>  
 length\_measure\_with\_unit}  
 measure\_with\_unit  
 [measure\_with\_unit.value\_component]  
 [measure\_with\_unit.unit\_component]

**5.1.5.5 Cross\_section\_round**

AIM element: hvac\_cross\_section

Source: 227

Reference path: hvac\_cross\_section <=  
 shape\_aspect  
 {shape\_aspect.description = 'round'}

**5.1.5.5.1 radius**

AIM element: [measure\_with\_unit.value\_component]  
 [measure\_with\_unit.unit\_component]

Source: 41

Rules: subtype\_mandatory\_shape\_representation

Reference path: hvac\_cross\_section <=  
 shape\_aspect <-  
 [shape\_aspect\_relationship.relate\_shape\_aspect  
 {shape\_aspect\_relationship  
 shape\_aspect\_relationship.name = 'cross section dimensional aspect'}  
 shape\_aspect\_relationship  
 shape\_aspect\_relationship.related\_shape\_aspect ->  
 shape\_aspect <-  
 shape\_aspect\_relationship.relate\_shape\_aspect]  
 [shape\_aspect\_relationship.relate\_shape\_aspect  
 {shape\_aspect\_relationship  
 shape\_aspect\_relationship.name = 'cross section dimensional aspect'}  
 shape\_aspect\_relationship  
 shape\_aspect\_relationship.related\_shape\_aspect ->  
 shape\_aspect <-  
 shape\_aspect\_relationship.related\_shape\_aspect]  
 shape\_aspect\_relationship =>  
 dimensional\_location  
 dimensional\_characteristic = dimensional\_location  
 dimensional\_characteristic <-  
 dimensional\_characteristic\_representation.dimension  
 dimensional\_characteristic\_representation  
 dimensional\_characteristic\_representation.representation ->  
 shape\_dimension\_representation <=  
 shape\_representation <=  
 {representation  
 representation.name = 'hvac connector dimensional shape'}  
 representation  
 representation.items[i] ->  
 {representation\_item  
 representation\_item.name = 'radius'}  
 representation\_item =>  
 measure\_representation\_item <=  
 {measure\_with\_unit =>  
 length\_measure\_with\_unit}

```

measure_with_unit
[measure_with_unit.value_component]
[measure_with_unit.unit_component]

```

### 5.1.5.6 Cross\_section\_triangular

AIM element:      hvac\_cross\_section

Source:            227

Reference path:   hvac\_cross\_section <=  
                      shape\_aspect  
                      {shape\_aspect.description = 'triangular'}

#### 5.1.5.6.1 vertex\_1

AIM element:      cartesian\_point

Source:            42

Reference path:   hvac\_cross\_section <=  
                      shape\_aspect  
                      shape\_definition = shape\_aspect  
                      shape\_definition  
                      characterized\_definition = shape\_definition  
                      characterized\_definition <=  
                      property\_definition.definition  
                      property\_definition  
                      represented\_definition = property\_definition  
                      represented\_definition <=  
                      property\_definition\_representation.definition  
                      property\_definition\_representation  
                      property\_definition\_representation.used\_representation ->  
                      representation  
                      {representation.name = 'cross section representation'}  
                      representation.items[i] ->  
                      representation\_item  
                      {representation\_item.name = 'vertex 1'}  
                      representation\_item =>  
                      geometric\_representation\_item =>  
                      point =>  
                      cartesian\_point

#### 5.1.5.6.2 vertex\_2

AIM element:      cartesian\_point

Source:            42

Reference path:   hvac\_cross\_section <=  
                      shape\_aspect  
                      shape\_definition = shape\_aspect  
                      shape\_definition

```

characterized_definition = shape_definition
characterized_definition <-
property_definition.definition
property_definition
represented_definition = property_definition
represented_definition <-
property_definition_representation.definition
property_definition_representation
property_definition_representation.used_representation ->
representation
{representation.name = 'cross section representation'}
representation.items[i] ->
representation_item
{representation_item.name = 'vertex 2'}
representation_item =>
geometric_representation_item =>
point =>
cartesian_point

```

### 5.1.5.6.3 vertex\_3

AIM element: cartesian\_point

Source: 42

Reference path:

```

hvac_cross_section <=
shape_aspect
shape_definition = shape_aspect
shape_definition
characterized_definition = shape_definition
characterized_definition <-
property_definition.definition
property_definition
represented_definition = property_definition
represented_definition <-
property_definition_representation.definition
property_definition_representation
property_definition_representation.used_representation ->
representation
{representation.name = 'cross section representation'}
representation.items[i] ->
representation_item
{representation_item.name = 'vertex 1'}
representation_item =>
geometric_representation_item =>
point =>
cartesian_point

```

### 5.1.5.7 Hvac\_connector

AIM element: hvac\_connector

Source: 227

Reference path: `hvac_connector <=`  
`shape_aspect`  
`{ shape_aspect`  
`shape_aspect.product_definitional = TRUE }`

### **5.1.5.7.1 name**

AIM element: `shape_aspect.name`

Source: 41

Reference path: `hvac_connector <=`  
`shape_aspect`  
`shape_aspect.name`

### **5.1.5.7.2 hvac\_connector\_specification**

AIM element: `document`

Source: 41

Reference path: `hvac_connector`  
`document_item = hvac_connector`  
`document_item <-`  
`applied_document_reference.items[i]`  
`applied_document_reference <=`  
`document_reference`  
`document_reference.assigned_document ->`  
`{ document`  
`document.kind ->`  
`document_type`  
`document_type.product_data_type = 'hvac connector specification' }`  
`document`

### **5.1.5.7.3 hvac\_joint\_inspection\_specification**

AIM element: `document`

Source: 41

Reference path: `hvac_connector`  
`document_item = hvac_connector`  
`document_item <-`  
`applied_document_reference.items[i]`  
`applied_document_reference <=`  
`document_reference`  
`document_reference.assigned_document ->`  
`{ document`  
`document.kind ->`  
`document_type`

```
document_type.product_data_type = 'hvac connector inspection specification'}
document
```

#### 5.1.5.7.4 connector\_flow\_direction

AIM element: descriptive\_representation\_item.description

Source: 45

Reference path: hvac\_connector <=  
 shape\_aspect  
 shape\_definition = shape\_aspect  
 shape\_definition  
 characterized\_definition = shape\_definition  
 characterized\_definition <=  
 property\_definition.definition  
 property\_definition  
 represented\_definition = property\_definition  
 represented\_definition <=  
 property\_definition\_representation.definition  
 property\_definition\_representation  
 property\_definition\_representation.used\_representation ->  
 representation  
 {representation.name = 'hvac connector characteristics'}  
 representation.items[i] ->  
 {representation\_item  
 representation\_item.name = 'flow direction'}  
 representation\_item =>  
 descriptive\_representation\_item  
 descriptive\_representation\_item.description

#### 5.1.5.7.5 hvac\_joint\_test\_specification

AIM element: document

Source: 41

Reference path: hvac\_connector  
 document\_item = hvac\_connector  
 document\_item <=  
 applied\_document\_reference.items[i]  
 applied\_document\_reference <=  
 document\_reference  
 document\_reference.assigned\_document ->  
 {document  
 document.kind ->  
 document\_type  
 document\_type.product\_data\_type = 'hvac connector test specification'}  
 document

**5.1.5.7.6 hvac\_joint\_engagement\_length**

AIM element: [measure\_with\_unit.value\_component]  
[measure\_with\_unit.unit\_component]

Source: 41

Reference path: hvac\_connector <=  
shape\_aspect  
shape\_definition = shape\_aspect  
shape\_definition  
characterized\_definition = shape\_definition  
characterized\_definition <=  
property\_definition.definition  
property\_definition  
represented\_definition = property\_definition  
represented\_definition <=  
property\_definition\_representation.definition  
property\_definition\_representation  
property\_definition\_representation.used\_representation ->  
representation  
representation.items[i] ->  
representation\_item =>  
{representation\_item.name = 'engagement length'}  
measure\_representation\_item <=  
{measure\_with\_unit =>  
length\_measure\_with\_unit}  
measure\_with\_unit  
[measure\_with\_unit.value\_component]  
[measure\_with\_unit.unit\_component]

**5.1.5.7.7 hvac\_joint\_joining\_type**

AIM element: group.name

Source: 41

Reference path: hvac\_connector  
classification\_item = hvac\_connector  
classification\_item <=  
applied\_classification\_assignment.items[i]  
applied\_classification\_assignment <=  
{classification\_assignment  
classification\_assignment.role ->  
classification\_role  
classification\_role.name = 'hvac joint joining type classification'}  
classification\_assignment  
classification\_assignment.assigned\_classification ->  
group  
group.name

**5.1.5.7.8 hvac\_joint\_sealant\_type**

AIM element: group.name

Source: 41

Reference path: hvac\_connector  
 classification\_item = hvac\_connector  
 classification\_item <-  
 applied\_classification\_assignment.items[i]  
 applied\_classification\_assignment <=  
 {classification\_assignment  
 classification\_assignment.role ->  
 classification\_role  
 classification\_role.name = 'hvac joint sealant type classification'}  
 classification\_assignment  
 classification\_assignment.assigned\_classification ->  
 group  
 group.name

**5.1.5.7.9 hvac\_joint\_joint\_type**

AIM element: group.name

Source: 41

Reference path: hvac\_connector  
 classification\_item = hvac\_connector  
 classification\_item <-  
 applied\_classification\_assignment.items[i]  
 applied\_classification\_assignment <=  
 {classification\_assignment  
 classification\_assignment.role ->  
 classification\_role  
 classification\_role.name = 'hvac joint type classification'}  
 classification\_assignment  
 classification\_assignment.assigned\_classification ->  
 group  
 group.name

**5.1.5.7.10 hvac\_joint\_tightness**

AIM element: group.name

Source: 41

Reference path: hvac\_connector  
 classification\_item = hvac\_connector  
 classification\_item <-  
 applied\_classification\_assignment.items[i]  
 applied\_classification\_assignment <=  
 {classification\_assignment  
 classification\_assignment.role ->

```

classification_role
classification_role.name = 'hvac joint tightness classification'}
classification_assignment
classification_assignment.assigned_classification ->
group
group.name

```

#### 5.1.5.7.11 hvac\_connector to hvac\_cross\_section

AIM element: PATH

Reference path: hvac\_connector <=  
 shape\_aspect <=  
 shape\_aspect\_relationship.relate\_shape\_aspect  
 shape\_aspect\_relationship  
 shape\_aspect\_relationship.related\_shape\_aspect ->  
 shape\_aspect =>  
 hvac\_cross\_section

#### 5.1.5.7.12 hvac\_connector to hvac\_connector\_service\_characteristic

AIM element: PATH

Reference path: hvac\_connector <=  
 shape\_aspect  
 shape\_definition = shape\_aspect  
 shape\_definition  
 characterized\_definition = shape\_definition  
 characterized\_definition <=  
 property\_definition.definition  
 {property\_definition  
 property\_definition.name = 'hvac service characteristics'}  
 property\_definition

### 5.1.5.8 Hvac\_connector\_service\_characteristic

AIM element: property\_definition

Source: 41

Reference path: property\_definition  
 {property\_definition.name = 'hvac service characteristic'}

#### 5.1.5.8.1 design\_pressure

AIM element: [measure\_with\_unit.value\_component]  
 [measure\_with\_unit.unit\_component]

Source: 41

Reference path: property\_definition  
 represented\_definition = property\_definition

```

represented_definition <-
property_definition_representation.definition
property_definition_representation
property_definition_representation.using_representation ->
representation
{representation.name = 'design service characteristics'}
(representation.items[i] ->
{representation_item
(representation_item.name = 'pressure')
(representation_item.name = 'maximum pressure')
(representation_item.name = 'minimum pressure'}})
([representation.items[i] ->
{representation_item
representation_item.name = 'maximum pressure'}}]
[representation.items[i] ->
{representation_item
representation_item.name = 'minimum pressure'}}])
representation_item =>
measure_representation_item <=
measure_with_unit
[measure_with_unit.value_component]
[measure_with_unit.unit_component]

```

### 5.1.5.8.2 design\_temperature

AIM element: [measure\_with\_unit.value\_component]  
[measure\_with\_unit.unit\_component]

Source: 41

Reference path: property\_definition  
represented\_definition = property\_definition  
represented\_definition <-  
property\_definition\_representation.definition  
property\_definition\_representation  
property\_definition\_representation.using\_representation ->  
representation  
{representation.name = 'design service characteristics'}  
(representation.items[i] ->  
{representation\_item  
(representation\_item.name = 'temperature')  
(representation\_item.name = 'maximum temperature')  
(representation\_item.name = 'minimum temperature'}})  
([representation.items[i] ->  
{representation\_item  
representation\_item.name = 'maximum temperature'}}]  
[representation.items[i] ->  
{representation\_item  
representation\_item.name = 'minimum temperature'}}])  
representation\_item =>  
measure\_representation\_item <=  
measure\_with\_unit  
[measure\_with\_unit.value\_component]

[measure\_with\_unit.unit\_component]

### 5.1.5.8.3 **hvac\_connector\_service\_characteristic to service\_operating\_-case**

AIM element: PATH

Reference path: property\_definition <-  
property\_definition\_relationship.related\_property\_definition  
property\_definition\_relationship

### 5.1.5.9 **Hvac\_cross\_section**

AIM element: hvac\_cross\_section

Source: 227

Reference path: hvac\_cross\_section <=  
shape\_aspect

#### 5.1.5.9.1 **equivalent\_length**

AIM element: [measure\_with\_unit.value\_component]  
[measure\_with\_unit.unit\_component]

Source: 41

Rules: subtype\_mandatory\_shape\_representation

Reference path: hvac\_cross\_section <=  
shape\_aspect <-  
[shape\_aspect\_relationship.relate\_shape\_aspect  
{ shape\_aspect\_relationship  
shape\_aspect\_relationship.name = 'cross section dimensional aspect'  
shape\_aspect\_relationship  
shape\_aspect\_relationship.related\_shape\_aspect ->  
shape\_aspect <-  
shape\_aspect\_relationship.relate\_shape\_aspect]  
[shape\_aspect\_relationship.relate\_shape\_aspect  
{ shape\_aspect\_relationship  
shape\_aspect\_relationship.name = 'cross section dimensional aspect'  
shape\_aspect\_relationship  
shape\_aspect\_relationship.related\_shape\_aspect ->  
shape\_aspect <-  
shape\_aspect\_relationship.related\_shape\_aspect]  
shape\_aspect\_relationship =>  
dimensional\_location  
dimensional\_characteristic = dimensional\_location  
dimensional\_characteristic <-  
dimensional\_characteristic\_representation.dimension  
dimensional\_characteristic\_representation  
dimensional\_characteristic\_representation.representation ->  
shape\_dimension\_representation <=

```

shape_representation <=
{representation
representation.name = 'hvac connector dimensional shape'}
representation
representation.items[i] ->
{representation_item
representation_item.name = 'equivalent length'}
representation_item =>
measure_representation_item <=
{measure_with_unit =>
length_measure_with_unit}
measure_with_unit
[measure_with_unit.value_component]
[measure_with_unit.unit_component]

```

### 5.1.5.10 Hvac\_branch\_connection

AIM element: hvac\_branch\_connection

Source: 227

Reference path: hvac\_branch\_connection <=

```

shape_aspect_relationship
{shape_aspect_relationship
[shape_aspect_relationship.description = 'branch location']
[shape_aspect_relationship.relate_shape_aspect ->
shape_aspect
shape_aspect.of_shape ->
product_definition_shape <=
property_definition
property_definition.definition ->
characterized_definition
characterized_definition = characterized_product_definition
characterized_product_definition
characterized_product_definition = product_definition
product_definition =>
hvac_section_segment_definition]
[shape_aspect_relationship.relate_shape_aspect ->
shape_aspect =>
hvac_section_segment_termination]]}

```

#### 5.1.5.10.1 branch\_sequence\_id

AIM element: shape\_aspect\_relationship.name

Source: 41

Reference path: hvac\_branch\_connection <=

```

{shape_aspect_relationship
shape_aspect_relationship.relate_shape_aspect ->
shape_aspect
shape_aspect.of_shape ->
product_definition_shape <-

```

```

[shape_aspect.of_shape
shape_aspect
shape_aspect.description = 'termination 1']
[shape_aspect.of_shape
shape_aspect
shape_aspect.description = 'termination 2']]
shape_aspect_relationship
shape_aspect_relationship.name

```

### 5.1.5.11 Hvac\_plant\_item\_branch\_connector

AIM element: hvac\_connector

Source: 227

Reference path: hvac\_connector <=  
 shape\_aspect  
 { shape\_aspect  
 shape\_aspect.description = 'hvac plant item branch connector' }

#### 5.1.5.11.1 hvac\_plant\_item\_branch\_connector to hvac\_plant\_item\_branch\_connection

AIM element: PATH

Reference path: hvac\_connector <=  
 shape\_aspect <=  
 shape\_aspect\_relationship.related\_shape\_aspect  
 shape\_aspect\_relationship =>  
 hvac\_plant\_item\_branch\_connection

### 5.1.5.12 Hvac\_plant\_item\_connector

AIM element: hvac\_connector

Source: 227

Reference path: hvac\_connector <=  
 shape\_aspect  
 { shape\_aspect  
 shape\_aspect.description = 'hvac plant item connector' }

#### 5.1.5.12.1 hvac\_plant\_item\_connector to hvac\_plant\_item\_connection

AIM element: PATH

Reference path: hvac\_connector <=  
 shape\_aspect <=  
 shape\_aspect\_relationship.related\_shape\_aspect  
 shape\_aspect\_relationship =>  
 hvac\_plant\_item\_connection

## 5.1.6 HVAC\_component\_characterization UoF

### 5.1.6.1 Hvac\_access\_opening

AIM element: shape\_aspect

Source: 41

Reference path: shape\_aspect  
{shape\_aspect.description = 'hvac access opening'}

#### 5.1.6.1.1 shape

AIM element: curve

Source: 42

Reference path: shape\_aspect  
 shape\_definition = shape\_aspect  
 shape\_definition  
 characterized\_definition = shape\_definition  
 characterized\_definition <-  
 property\_definition.definition  
 property\_definition  
 represented\_definition = property\_definition  
 represented\_definition <-  
 property\_definition\_representation.definition  
 property\_definition\_representation  
 property\_definition\_representation.used\_representation ->  
 representation  
 {representation.name = 'hvac access opening representation'}  
 representation.items[i] ->  
 representation\_item  
 {representation\_item.name = 'hvac access opening shape'}  
 representation\_item =>  
 geometric\_representation\_item =>  
 curve

#### 5.1.6.1.2 access\_opening\_id

AIM element: shape\_aspect.name

Source: 41

#### 5.1.6.1.3 access\_type

AIM element: group.name

Source: 41

Reference path: shape\_aspect  
 classification\_item = shape\_aspect

```

classification_item <-
applied_classification_assignment.items[i]
applied_classification_assignment <=
{classification_assignment
classification_assignment.role ->
classification_role
classification_role.name = 'hvac access opening type classification'}
classification_assignment
classification_assignment.assigned_classification ->
group
group.name

```

### 5.1.6.2 Hvac\_bend

AIM element: hvac\_component\_definition

Source: 227

Rules: dependent\_instantiable\_product\_context  
product\_context\_discipline\_type\_constraint  
value\_for\_application\_context

Reference path: hvac\_component\_definition <=

```

product_definition
{hvac_component_definition
classification_item = hvac_component_definition
classification_item <-
applied_classification_assignment.items[i]
applied_classification_assignment <=
classification_assignment
classification_assignment.assigned_classification ->
[group =>
hvac_fitting_class]
[group
group.name = 'hvac bend']}
{product_definition
product_definition.formation ->
product_definition_formation
product_definition_formation.of_product ->
[product
classification_item = product
classification_item <-
applied_classification_assignment.items[i]
applied_classification_assignment <=
classification_assignment
classification_assignment.assigned_classification ->
(group)
(group <-
group_relationship.related_group
group_relationship
group_relationship.relate_group ->
group)
group.name = 'hvac fitting']

```

```
[product
product.frame_of_reference[i] ->
product_context <=
application_context_element
application_context_element.name = 'plant item']])
```

### 5.1.6.2.1 length

AIM element: [measure\_with\_unit.value\_component]  
[measure\_with\_unit.unit\_component]

Source: 41

Rules: subtype\_mandatory\_shape\_representation

Reference path: hvac\_component\_definition <=  
product\_definition  
characterized\_product\_definition = product\_definition  
characterized\_product\_definition  
characterized\_definition = characterized\_product\_definition  
characterized\_definition <=  
property\_definition.definition  
property\_definition =>  
product\_definition\_shape <=  
shape\_aspect.of\_shape  
[shape\_aspect <=  
shape\_aspect\_relationship.relating\_shape\_aspect]  
[shape\_aspect <=  
shape\_aspect\_relationship.related\_shape\_aspect]  
shape\_aspect\_relationship =>  
dimensional\_location  
dimensional\_characteristic = dimensional\_location  
dimensional\_characteristic <=  
dimensional\_characteristic\_representation.dimension  
dimensional\_characteristic\_representation  
dimensional\_characteristic\_representation.representation ->  
shape\_dimension\_representation <=  
shape\_representation <=  
{representation  
representation.name = 'hvac bend dimensional shape'}  
representation  
representation.items[i] ->  
representation\_item =>  
{representation\_item.name = 'length'}  
measure\_representation\_item <=  
{measure\_with\_unit =>  
length\_measure\_with\_unit}  
measure\_with\_unit  
[measure\_with\_unit.value\_component]  
[measure\_with\_unit.unit\_component]

### 5.1.6.2.2 bend\_path

AIM element: curve

Source: 42

Reference path: hvac\_component\_definition <=  
product\_definition  
characterized\_product\_definition = product\_definition  
characterized\_product\_definition  
characterized\_definition = characterized\_product\_definition  
characterized\_definition <=  
property\_definition.definition  
property\_definition =>  
product\_definition\_shape <=  
shape\_aspect.of\_shape  
shape\_aspect  
{shape\_aspect.name = 'bend path'}  
shape\_definition = shape\_aspect  
shape\_definition  
characterized\_definition = shape\_definition  
characterized\_definition <=  
property\_definition.definition  
property\_definition  
represented\_definition = property\_definition  
represented\_definition <=  
property\_definition\_representation.definition  
property\_definition\_representation  
property\_definition\_representation.used\_representation ->  
representation  
{representation.name = 'hvac bend representation'}  
representation.items[i] ->  
representation\_item  
{representation\_item.name = 'bend path'}  
representation\_item =>  
geometric\_representation\_item =>  
curve

### 5.1.6.2.3 end\_1\_connector

AIM element: hvac\_connector

Source: 227

Reference path: hvac\_component\_definition <=  
product\_definition  
characterized\_product\_definition = product\_definition  
characterized\_product\_definition  
characterized\_definition = characterized\_product\_definition  
characterized\_definition <=  
property\_definition.definition  
property\_definition =>  
product\_definition\_shape <=  
shape\_aspect.of\_shape  
shape\_aspect  
{shape\_aspect.description = 'end 1'}

```

shape_aspect =>
hvac_connector

```

#### 5.1.6.2.4 end\_2\_connector

AIM element: hvac\_connector

Source: 227

Reference path:

```

hvac_component_definition <=
product_definition
characterized_product_definition = product_definition
characterized_product_definition
characterized_definition = characterized_product_definition
characterized_definition <-
property_definition.definition
property_definition =>
product_definition_shape <-
shape_aspect.of_shape
{shape_aspect
shape_aspect.description = 'end 2'}
shape_aspect =>
hvac_connector

```

#### 5.1.6.3 Hvac\_component

AIM element: product

Source: 41

Rules:

```

dependent_instantiable_product_context
product_context_discipline_type_constraint
value_for_application_context

```

Reference path:

```

{[product
classification_item = product
classification_item <-
applied_classification_assignment.items[i]
applied_classification_assignment <=
classification_assignment
classification_assignment.assigned_classification ->
group
group.name = 'hvac component']
[product
product.frame_of_reference[i] ->
product_context<=
application_context_element
application_context_element.name = 'plant item']]

```

### 5.1.6.3.1 design\_flow\_rate

AIM element: [measure\_with\_unit.value\_component]  
[measure\_with\_unit.unit\_component]

Source: 41

Reference path: product <-  
product\_definition\_formation.of\_product  
product\_definition\_formation <-  
product\_definition.formation  
product\_definition  
characterized\_product\_definition = product\_definition  
characterized\_product\_definition  
characterized\_definition = characterized\_product\_definition  
characterized\_definition <-  
property\_definition.definition  
property\_definition <-  
property\_definition\_representation.definition  
property\_definition\_representation  
property\_definition\_representation.using\_representation ->  
representation  
{representation.name = 'hvac flow characteristics'}  
(representation.items[i] ->  
{representation\_item  
(representation\_item.name = 'flow rate')  
(representation\_item.name = 'maximum flow rate')  
(representation\_item.name = 'minimum flow rate'}})  
([representation.items[i] ->  
{representation\_item  
representation\_item.name = 'maximum flow rate'}}]  
[representation.items[i] ->  
{representation\_item  
representation\_item.name = 'minimum flow rate'}}])  
representation\_item =>  
measure\_representation\_item <=  
measure\_with\_unit  
[measure\_with\_unit.value\_component]  
[measure\_with\_unit.unit\_component]

### 5.1.6.3.2 design\_flow\_condition

AIM element: descriptive\_representation\_item.description

Source: 45

Reference path: product <-  
product\_definition\_formation.of\_product  
product\_definition\_formation <-  
product\_definition.formation  
product\_definition  
characterized\_product\_definition = product\_definition  
characterized\_product\_definition  
characterized\_definition = characterized\_product\_definition

```

characterized_definition <-
property_definition.definition
property_definition <-
property_definition_representation.definition
property_definition_representation
property_definition_representation.using_representation ->
representation
{representation.name = 'hvac flow characteristics'}
representation.items[i] ->
representation_item
{representation_item.name = 'design flow condition'}
representation_item =>
descriptive_representation_item
descriptive_representation_item.description

```

### 5.1.6.3.3 design\_pressure

AIM element: [measure\_with\_unit.value\_component]  
[measure\_with\_unit.unit\_component]

Source: 41

Reference path:

```

product <-
product_definition_formation.of_product
product_definition_formation <-
product_definition.formation
product_definition
characterized_product_definition = product_definition
characterized_product_definition
characterized_definition = characterized_product_definition
characterized_definition <-
property_definition.definition
property_definition <-
represented_definition = property_definition
represented_definition <-
property_definition_representation.definition
property_definition_representation
property_definition_representation.using_representation ->
representation
{representation.name = 'hvac flow characteristics'}
(representation.items[i] ->
{representation_item
(representation_item.name = 'pressure')
(representation_item.name = 'maximum pressure')
(representation_item.name = 'minimum pressure')}}
([representation.items[i] ->
{representation_item
representation_item.name = 'maximum pressure'}}
[representation.items[i] ->
{representation_item
representation_item.name = 'minimum pressure'}}])
representation_item =>
measure_representation_item <=
measure_with_unit

```

[measure\_with\_unit.value\_component]  
[measure\_with\_unit.unit\_component]

#### 5.1.6.3.4 design\_temperature

AIM element: [measure\_with\_unit.value\_component]  
[measure\_with\_unit.unit\_component]

Source: 41

Reference path: product <-  
product\_definition\_formation.of\_product  
product\_definition\_formation <-  
product\_definition.formation  
product\_definition  
characterized\_product\_definition = product\_definition  
characterized\_product\_definition  
characterized\_definition = characterized\_product\_definition  
characterized\_definition <-  
property\_definition.definition  
property\_definition <-  
represented\_definition = property\_definition  
represented\_definition <-  
property\_definition\_representation.definition  
property\_definition\_representation  
property\_definition\_representation.using\_representation ->  
representation  
{representation.name = 'hvac flow characteristics'}  
(representation.items[i] ->  
{representation\_item  
(representation\_item.name = 'temperature')  
(representation\_item.name = 'maximum temperature')  
(representation\_item.name = 'minimum temperature'))}  
([representation.items[i] ->  
{representation\_item  
representation\_item.name = 'maximum temperature'}}]  
[representation.items[i] ->  
{representation\_item  
representation\_item.name = 'minimum temperature'}}])  
representation\_item =>  
measure\_representation\_item <=  
measure\_with\_unit  
[measure\_with\_unit.value\_component]  
[measure\_with\_unit.unit\_component]

#### 5.1.6.3.5 pressure\_loss\_coefficient

AIM element: [measure\_with\_unit.value\_component]  
[measure\_with\_unit.unit\_component]

Source: 41

Reference path: product <-

```

product_definition_formation.of_product
product_definition_formation <-
product_definition.formation
product_definition
characterized_product_definition = product_definition
characterized_product_definition
characterized_definition = characterized_product_definition
characterized_definition <-
property_definition.definition
property_definition <-
represented_definition = property_definition
represented_definition <-
property_definition_representation.definition
property_definition_representation
property_definition_representation.using_representation ->
representation
{representation.name = 'hvac flow characteristics'}
(representation.items[i] ->
{representation_item
(representation_item.name = 'pressure loss coefficient')
(representation_item.name = 'maximum pressure loss coefficient')
(representation_item.name = 'minimum pressure loss coefficient'}})
([representation.items[i] ->
{representation_item
representation_item.name = 'maximum pressure loss coefficient'}}
[representation.items[i] ->
{representation_item
representation_item.name = 'minimum pressure loss coefficient'}})
representation_item =>
measure_representation_item <=
measure_with_unit
[measure_with_unit.value_component]
[measure_with_unit.unit_component]

```

### 5.1.6.3.6 pressure\_drop

AIM element: [measure\_with\_unit.value\_component]  
[measure\_with\_unit.unit\_component]

Source: 41

Reference path: product <-  
product\_definition\_formation.of\_product  
product\_definition\_formation <-  
product\_definition.formation  
product\_definition  
characterized\_product\_definition = product\_definition  
characterized\_product\_definition  
characterized\_definition = characterized\_product\_definition  
characterized\_definition <-  
property\_definition.definition  
property\_definition <-  
represented\_definition = property\_definition  
represented\_definition <-

```

property_definition_representation.definition
property_definition_representation
property_definition_representation.using_representation ->
representation
{representation.name = 'hvac flow characteristics'}
(representation.items[i] ->
{representation_item
(representation_item.name = 'pressure drop')
(representation_item.name = 'maximum pressure drop')
(representation_item.name = 'minimum pressure drop'))}
([representation.items[i] ->
{representation_item
representation_item.name = 'maximum pressure drop'}}
[representation.items[i] ->
{representation_item
representation_item.name = 'minimum pressure drop'}}])
representation_item =>
measure_representation_item <=
measure_with_unit
[measure_with_unit.value_component]
[measure_with_unit.unit_component]

```

### 5.1.6.3.7 velocity

AIM element: [measure\_with\_unit.value\_component]  
[measure\_with\_unit.unit\_component]

Source: 41

Reference path: product <-  
product\_definition\_formation.of\_product  
product\_definition\_formation <-  
product\_definition.formation  
product\_definition  
characterized\_product\_definition = product\_definition  
characterized\_product\_definition  
characterized\_definition = characterized\_product\_definition  
characterized\_definition <-  
property\_definition.definition  
property\_definition <-  
represented\_definition = property\_definition  
represented\_definition <-  
property\_definition\_representation.definition  
property\_definition\_representation  
property\_definition\_representation.using\_representation ->  
representation  
{representation.name = 'hvac flow characteristics'}  
(representation.items[i] ->  
{representation\_item  
(representation\_item.name = 'velocity')  
(representation\_item.name = 'maximum velocity')  
(representation\_item.name = 'minimum velocity'))}  
([representation.items[i] ->  
{representation\_item

```

representation_item.name = 'maximum velocity'}}
[representation.items[i] ->
{representation_item
representation_item.name = 'minimum velocity'}})
representation_item =>
measure_representation_item <=
measure_with_unit
[measure_with_unit.value_component]
[measure_with_unit.unit_component]

```

#### 5.1.6.3.8 hvac\_component to hvac\_component\_thickness

AIM element: PATH

Reference path:

```

product <-
product_definition_formation.of_product
product_definition_formation <-
product_definition.formation
product_definition
characterized_product_definition = product_definition
characterized_product_definition
characterized_definition = characterized_product_definition
characterized_definition <-
property_definition.definition
property_definition <-
property_definition_representation.definition
property_definition_representation
property_definition_representation.using_representation ->
representation
{representation.name = 'hvac component thickness'}

```

#### 5.1.6.3.9 hvac\_component to hvac\_access\_opening

AIM element: PATH

Reference path:

```

product <-
product_definition_formation.of_product
product_definition_formation <-
product_definition.formation
product_definition
characterized_product_definition = product_definition
characterized_product_definition
characterized_definition = characterized_product_definition
characterized_definition <-
property_definition.definition
property_definition =>
product_definition_shape <-
shape_aspect.of_shape
shape_aspect

```

#### 5.1.6.4 Hvac\_component\_thickness

AIM element: representation

Source: 43

Reference path: representation  
{representation.name = 'hvac component thickness'}

#### 5.1.6.4.1 sheet\_metal\_thickness

AIM element: [measure\_with\_unit.value\_component]  
[measure\_with\_unit.unit\_component]

Source: 41

Reference path: representation  
{representation.name = 'hvac component\_thickness'}  
(representation.items[i] ->  
{representation\_item  
(representation\_item.name = 'thickness')  
(representation\_item.name = 'maximum thickness')  
(representation\_item.name = 'minimum thickness'}})  
([representation.items[i] ->  
{representation\_item  
representation\_item.name = 'maximum thickness'}}]  
[representation.items[i] ->  
{representation\_item  
representation\_item.name = 'minimum thickness'}}])  
representation\_item =>  
measure\_representation\_item <=  
{measure\_with\_unit =>  
length\_measure\_with\_unit}  
measure\_with\_unit  
[measure\_with\_unit.value\_component]  
[measure\_with\_unit.unit\_component]

#### 5.1.6.4.2 thickness\_type

AIM element: descriptive\_representation\_item

Source: 45

Reference path: representation  
{representation.name = 'hvac component\_thickness'}  
representation.items[i] ->  
representation\_item  
{representation\_item.name = 'thickness type')  
representation\_item =>  
descriptive\_representation\_item  
descriptive\_representation\_item.description

#### 5.1.6.5 Hvac\_coupling

AIM element: hvac\_component\_definition

Source: 227

Rules: dependent\_instantiable\_product\_context  
product\_context\_discipline\_type\_constraint  
value\_for\_application\_context

Reference path: hvac\_component\_definition <=  
product\_definition  
{hvac\_component\_definition  
classification\_item = hvac\_component\_definition  
classification\_item <=  
applied\_classification\_assignment.items[i]  
applied\_classification\_assignment <=  
classification\_assignment  
classification\_assignment.assigned\_classification ->  
[group =>  
hvac\_fitting\_class]  
[group  
group.name = 'hvac coupling']}  
{product\_definition  
product\_definition.formation ->  
product\_definition\_formation  
product\_definition\_formation.of\_product ->  
[product  
classification\_item = product  
classification\_item <=  
applied\_classification\_assignment.items[i]  
applied\_classification\_assignment <=  
classification\_assignment  
classification\_assignment.assigned\_classification ->  
(group)  
(group <=  
group\_relationship.related\_group  
group\_relationship  
group\_relationship.relying\_group ->  
group)  
group.name = 'hvac fitting']  
[product  
product.frame\_of\_reference[i] ->  
product\_context <=  
application\_context\_element  
application\_context\_element.name = 'plant item']]}

#### 5.1.6.5.1 offset\_x

AIM element: [measure\_with\_unit.value\_component]  
[measure\_with\_unit.unit\_component]

Source: 41

Rules: subtype\_mandatory\_shape\_representation

Reference path: hvac\_component\_definition <=  
product\_definition  
characterized\_product\_definition = product\_definition  
characterized\_product\_definition  
characterized\_definition = characterized\_product\_definition  
characterized\_definition <=  
property\_definition.definition  
property\_definition =>  
product\_definition\_shape <=  
shape\_aspect.of\_shape  
[shape\_aspect <=  
shape\_aspect\_relationship.relate\_shape\_aspect]  
[shape\_aspect <=  
shape\_aspect\_relationship.related\_shape\_aspect]  
shape\_aspect\_relationship =>  
dimensional\_location  
dimensional\_characteristic = dimensional\_location  
dimensional\_characteristic <=  
dimensional\_characteristic\_representation.dimension  
dimensional\_characteristic\_representation  
dimensional\_characteristic\_representation.representation ->  
shape\_dimension\_representation <=  
shape\_representation <=  
{representation  
representation.name = 'hvac coupling dimensional shape'}  
representation  
representation.items[i] ->  
representation\_item =>  
{representation\_item.name = 'offset x'}  
measure\_representation\_item <=  
{measure\_with\_unit =>  
length\_measure\_with\_unit}  
measure\_with\_unit  
[measure\_with\_unit.value\_component]  
[measure\_with\_unit.unit\_component]

#### 5.1.6.5.2 offset\_y

AIM element: [measure\_with\_unit.value\_component]  
[measure\_with\_unit.unit\_component]

Source: 41

Rules: subtype\_mandatory\_shape\_representation

Reference path: hvac\_component\_definition <=  
product\_definition  
characterized\_product\_definition = product\_definition  
characterized\_product\_definition  
characterized\_definition = characterized\_product\_definition  
characterized\_definition <=  
property\_definition.definition

```

property_definition =>
product_definition_shape <-
shape_aspect.of_shape
[shape_aspect <-
shape_aspect_relationship.relating_shape_aspect]
[shape_aspect <-
shape_aspect_relationship.related_shape_aspect]
shape_aspect_relationship =>
dimensional_location
dimensional_characteristic = dimensional_location
dimensional_characteristic <-
dimensional_characteristic_representation.dimension
dimensional_characteristic_representation
dimensional_characteristic_representation.representation ->
shape_dimension_representation <=
shape_representation <=
{representation
representation.name = 'hvac coupling dimensional shape'}
representation
representation.items[i] ->
representation_item =>
{representation_item.name = 'offset y'}
measure_representation_item <=
{measure_with_unit =>
length_measure_with_unit}
measure_with_unit
[measure_with_unit.value_component]
[measure_with_unit.unit_component]

```

### 5.1.6.5.3 length

AIM element: [measure\_with\_unit.value\_component]  
[measure\_with\_unit.unit\_component]

Source: 41

Rules: subtype\_mandatory\_shape\_representation

Reference path: hvac\_component\_definition <=
product\_definition
characterized\_product\_definition = product\_definition
characterized\_product\_definition
characterized\_definition = characterized\_product\_definition
characterized\_definition <-
property\_definition.definition
property\_definition =>
product\_definition\_shape <-
shape\_aspect.of\_shape
[shape\_aspect <-
shape\_aspect\_relationship.relating\_shape\_aspect]
[shape\_aspect <-
shape\_aspect\_relationship.related\_shape\_aspect]
shape\_aspect\_relationship =>
dimensional\_location

```

dimensional_characteristic = dimensional_location
dimensional_characteristic <-
dimensional_characteristic_representation.dimension
dimensional_characteristic_representation
dimensional_characteristic_representation.representation ->
shape_dimension_representation <=
shape_representation <=
{representation
representation.name = 'hvac coupling dimensional shape'}
representation
representation.items[i] ->
representation_item =>
{representation_item.name = 'length'}
measure_representation_item <=
{measure_with_unit =>
length_measure_with_unit}
measure_with_unit
[measure_with_unit.value_component]
[measure_with_unit.unit_component]

```

#### 5.1.6.5.4 end\_1\_connector

AIM element: hvac\_connector

Source: 227

Reference path: hvac\_component\_definition <=

```

product_definition
characterized_product_definition = product_definition
characterized_product_definition
characterized_definition = characterized_product_definition
characterized_definition <-
property_definition.definition
property_definition =>
product_definition_shape <-
shape_aspect.of_shape
{shape_aspect
shape_aspect.description = 'end 1'}
shape_aspect =>
hvac_connector

```

#### 5.1.6.5.5 end\_2\_connector

AIM element: hvac\_connector

Source: 227

Reference path: hvac\_component\_definition <=

```

product_definition
characterized_product_definition = product_definition
characterized_product_definition
characterized_definition = characterized_product_definition
characterized_definition <-

```

```

property_definition.definition
property_definition =>
product_definition_shape <-
shape_aspect.of_shape
{ shape_aspect
shape_aspect.description = 'end 2' }
shape_aspect =>
hvac_connector

```

### 5.1.6.6 Hvac\_ducting

AIM element: product

Source: 41

Rules: dependent\_instantiable\_product\_context  
product\_context\_discipline\_type\_constraint  
value\_for\_application\_context

Reference path: {[product  
classification\_item = product  
classification\_item <-  
applied\_classification\_assignment.items[i]  
applied\_classification\_assignment <=  
classification\_assignment  
classification\_assignment.assigned\_classification ->  
[group  
group.name = 'hvac ducting']  
[group <-  
group\_relationship.related\_group  
{group\_relationship  
group\_relationship.name = 'usage classification'}  
group\_relationship  
group\_relationship.relying\_group ->  
group  
group.name = 'ducting component']  
[group <-  
group\_relationship.related\_group  
{group\_relationship  
group\_relationship.name = 'usage\_classification'}  
group\_relationship  
group\_relationship.relying\_group ->  
group  
group.name = 'hvac component']]  
[product  
product.frame\_of\_reference[i] ->  
product\_context<=  
application\_context\_element  
application\_context\_element.name = 'plant item']]}

#### 5.1.6.6.1 duct\_seam

AIM element: descriptive\_representation\_item.description

Source: 45

Reference path:

```

product <-
product_definition_formation.of_product
product_definition_formation <-
product_definition.formation
product_definition
characterized_product_definition = product_definition
characterized_product_definition
characterized_definition = characterized_product_definition
characterized_definition <-
property_definition.definition
property_definition
represented_definition = property_definition
represented_definition <-
property_definition_representation.definition
property_definition_representation
property_definition_representation.used_representation ->
representation
{representation.name = 'hvac ducting characteristics'}
representation.items[i] ->
{representation_item
representation_item.name = 'duct seam'}
representation_item =>
descriptive_representation_item
descriptive_representation_item.description

```

#### 5.1.6.6.2 length

AIM element: [measure\_with\_unit.value\_component]  
[measure\_with\_unit.unit\_component]

Source: 41

Reference path:

```

product <-
product_definition_formation.of_product
product_definition_formation <-
product_definition.formation
product_definition
characterized_product_definition = product_definition
characterized_product_definition
characterized_definition = characterized_product_definition
characterized_definition <-
property_definition.definition
property_definition =>
product_definition_shape <-
shape_aspect.of_shape
[shape_aspect <-
shape_aspect_relationship.relying_shape_aspect]
[shape_aspect <-
shape_aspect_relationship.related_shape_aspect]
shape_aspect_relationship =>

```

```

dimensional_location
dimensional_characteristic = dimensional_location
dimensional_characteristic <-
dimensional_characteristic_representation.dimension
dimensional_characteristic_representation
dimensional_characteristic_representation.representation ->
shape_dimension_representation <=
shape_representation <=
{representation
representation.name = 'hvac ducting dimensional shape'}
representation
representation.items[i] ->
representation_item =>
{representation_item.name = 'length'}
measure_representation_item <=
{measure_with_unit =>
length_measure_with_unit}
measure_with_unit
[measure_with_unit.value_component]
[measure_with_unit.unit_component]

```

### 5.1.6.6.3 end\_1\_connector

AIM element: hvac\_connector

Source: 227

Reference path:

```

product <-
product_definition_formation.of_product
product_definition_formation <-
product_definition.formation
product_definition
characterized_product_definition = product_definition
characterized_product_definition
characterized_definition = characterized_product_definition
characterized_definition <-
property_definition.definition
property_definition =>
product_definition_shape <-
shape_aspect.of_shape
{shape_aspect
shape_aspect.description = 'end 1'}
shape_aspect =>
hvac_connector

```

### 5.1.6.6.4 end\_2\_connector

AIM element: hvac\_connector

Source: 227

Reference path:

```

product <-
product_definition_formation.of_product

```

```

product_definition_formation <-
product_definition.formation
product_definition
characterized_product_definition = product_definition
characterized_product_definition
characterized_definition = characterized_product_definition
characterized_definition <-
property_definition.definition
property_definition =>
product_definition_shape <-
shape_aspect.of_shape
{shape_aspect
shape_aspect.description = 'end 2'}
shape_aspect =>
hvac_connector

```

### 5.1.6.6.5 duct\_path

AIM element: curve

Source: 42

Reference path:

```

product <-
product_definition_formation.of_product
product_definition_formation <-
product_definition.formation
product_definition
characterized_product_definition = product_definition
characterized_product_definition
characterized_definition = characterized_product_definition
characterized_definition <-
property_definition.definition
property_definition =>
product_definition_shape <-
shape_aspect.of_shape
shape_aspect
{shape_aspect.name = 'duct path'}
shape_definition = shape_aspect
shape_definition
characterized_definition = shape_definition
characterized_definition <-
property_definition.definition
property_definition
represented_definition = property_definition
represented_definition <-
property_definition_representation.definition
property_definition_representation
property_definition_representation.used_representation ->
representation
{representation.name = 'duct path representation'}
representation.items[i] ->
representation_item
{representation_item.name = 'duct path'}
representation_item =>

```

```

geometric_representation_item =>
curve

```

### 5.1.6.7 Hvac\_elbow\_90deg\_reducing

AIM element: hvac\_component\_definition

Source: 227

Rules: dependent\_instantiable\_product\_context  
product\_context\_discipline\_type\_constraint  
value\_for\_application\_context

Reference path: hvac\_component\_definition <=  
product\_definition  
{hvac\_component\_definition  
classification\_item = hvac\_component\_definition  
classification\_item <-  
applied\_classification\_assignment.items[i]  
applied\_classification\_assignment <=  
classification\_assignment  
classification\_assignment.assigned\_classification ->  
[group =>  
hvac\_fitting\_class]  
[group  
group.name = 'hvac elbow 90deg reducing']}  
{product\_definition  
product\_definition.formation ->  
product\_definition\_formation  
product\_definition\_formation.of\_product ->  
[product  
classification\_item = product  
classification\_item <-  
applied\_classification\_assignment.items[i]  
applied\_classification\_assignment <=  
classification\_assignment  
classification\_assignment.assigned\_classification ->  
(group)  
(group <-  
group\_relationship.related\_group  
group\_relationship  
group\_relationship.relying\_group ->  
group)  
group.name = 'hvac fitting']  
[product  
product.frame\_of\_reference[i] ->  
product\_context <=  
application\_context\_element  
application\_context\_element.name = 'plant item']})

#### 5.1.6.7.1 angle

AIM element: [measure\_with\_unit.value\_component]  
[measure\_with\_unit.unit\_component]

Source: 41

Rules: subtype\_mandatory\_shape\_representation

Reference path: hvac\_component\_definition <=  
product\_definition  
characterized\_product\_definition = product\_definition  
characterized\_product\_definition  
characterized\_definition = characterized\_product\_definition  
characterized\_definition <=  
property\_definition.definition  
property\_definition =>  
product\_definition\_shape <=  
shape\_aspect.of\_shape  
[shape\_aspect <=  
shape\_aspect\_relationship.relating\_shape\_aspect]  
[shape\_aspect <=  
shape\_aspect\_relationship.related\_shape\_aspect]  
shape\_aspect\_relationship =>  
dimensional\_location  
dimensional\_characteristic = dimensional\_location  
dimensional\_characteristic <=  
dimensional\_characteristic\_representation.dimension  
dimensional\_characteristic\_representation  
dimensional\_characteristic\_representation.representation ->  
shape\_dimension\_representation <=  
shape\_representation <=  
{representation  
representation.name = 'hvac elbow dimensional shape'}  
representation  
representation.items[i] ->  
representation\_item =>  
{representation\_item.name = 'angle'}  
measure\_representation\_item <=  
{measure\_with\_unit =>  
plane\_angle\_measure\_with\_unit}  
measure\_with\_unit  
[measure\_with\_unit.value\_component]  
[measure\_with\_unit.unit\_component]

#### 5.1.6.7.2 throat\_radius

AIM element: [measure\_with\_unit.value\_component]  
[measure\_with\_unit.unit\_component]

Source: 41

Rules: subtype\_mandatory\_shape\_representation

Reference path: hvac\_component\_definition <=  
product\_definition

```

characterized_product_definition = product_definition
characterized_product_definition
characterized_definition = characterized_product_definition
characterized_definition <-
property_definition.definition
property_definition =>
product_definition_shape <-
shape_aspect.of_shape
[shape_aspect <-
shape_aspect_relationship.relating_shape_aspect]
[shape_aspect <-
shape_aspect_relationship.related_shape_aspect]
shape_aspect_relationship =>
dimensional_location
dimensional_characteristic = dimensional_location
dimensional_characteristic <-
dimensional_characteristic_representation.dimension
dimensional_characteristic_representation
dimensional_characteristic_representation.representation ->
shape_dimension_representation <=
shape_representation <=
{representation
representation.name = 'hvac elbow dimensional shape'}
representation
representation.items[i] ->
representation_item =>
{representation_item.name = 'throat radius'}
measure_representation_item <=
{measure_with_unit =>
length_measure_with_unit}
measure_with_unit
[measure_with_unit.value_component]
[measure_with_unit.unit_component]

```

### 5.1.6.7.3 heel\_radius

AIM element: [measure\_with\_unit.value\_component]  
[measure\_with\_unit.unit\_component]

Source: 41

Rules: subtype\_mandatory\_shape\_representation

Reference path: hvac\_component\_definition <=

```

product_definition
characterized_product_definition = product_definition
characterized_product_definition
characterized_definition = characterized_product_definition
characterized_definition <-
property_definition.definition
property_definition =>
product_definition_shape <-
shape_aspect.of_shape
[shape_aspect <-

```

```

shape_aspect_relationship.relate_shape_aspect]
[shape_aspect <-
shape_aspect_relationship.related_shape_aspect]
shape_aspect_relationship =>
dimensional_location
dimensional_characteristic = dimensional_location
dimensional_characteristic <-
dimensional_characteristic_representation.dimension
dimensional_characteristic_representation
dimensional_characteristic_representation.representation ->
shape_dimension_representation <=
shape_representation <=
{representation
representation.name = 'hvac elbow dimensional shape'}
representation
representation.items[i] ->
representation_item =>
{representation_item.name = 'heel radius'}
measure_representation_item <=
{measure_with_unit =>
length_measure_with_unit}
measure_with_unit
[measure_with_unit.value_component]
[measure_with_unit.unit_component]

```

#### 5.1.6.7.4 heel\_radius\_centre\_offset

AIM element: [measure\_with\_unit.value\_component]  
[measure\_with\_unit.unit\_component]

Source: 41

Rules: subtype\_mandatory\_shape\_representation

Reference path: hvac\_component\_definition <=

```

product_definition
characterized_product_definition = product_definition
characterized_product_definition
characterized_definition = characterized_product_definition
characterized_definition <-
property_definition.definition
property_definition =>
product_definition_shape <-
shape_aspect.of_shape
[shape_aspect <-
shape_aspect_relationship.relate_shape_aspect]
[shape_aspect <-
shape_aspect_relationship.related_shape_aspect]
shape_aspect_relationship =>
dimensional_location
dimensional_characteristic = dimensional_location
dimensional_characteristic <-
dimensional_characteristic_representation.dimension
dimensional_characteristic_representation

```

```

dimensional_characteristic_representation.representation ->
shape_dimension_representation <=
shape_representation <=
{representation
representation.name = 'hvac elbow dimensional shape'}
representation
representation.items[i] ->
representation_item =>
{representation_item.name = 'radius centre offset'}
measure_representation_item <=
{measure_with_unit =>
length_measure_with_unit}
measure_with_unit
[measure_with_unit.value_component]
[measure_with_unit.unit_component]

```

#### 5.1.6.7.5 end\_1\_connector

AIM element: hvac\_connector

Source: 227

Reference path: hvac\_component\_definition <=

```

product_definition
characterized_product_definition = product_definition
characterized_product_definition
characterized_definition = characterized_product_definition
characterized_definition <-
property_definition.definition
property_definition =>
product_definition_shape <-
shape_aspect.of_shape
{shape_aspect
shape_aspect.description = 'end 1'}
shape_aspect =>
hvac_connector

```

#### 5.1.6.7.6 end\_2\_connector

AIM element: hvac\_connector

Source: 227

Reference path: hvac\_component\_definition <=

```

product_definition
characterized_product_definition = product_definition
characterized_product_definition
characterized_definition = characterized_product_definition
characterized_definition <-
property_definition.definition
property_definition =>
product_definition_shape <-
shape_aspect.of_shape

```

```

{shape_aspect
shape_aspect.description = 'end 2'}
shape_aspect =>
hvac_connector

```

#### 5.1.6.7.7 **hvac\_elbow\_90deg\_reducing to splitter**

AIM element: PATH

Reference path: `hvac_component_definition <=`  
`product_definition`  
`characterized_product_definition = product_definition`  
`characterized_product_definition`  
`characterized_definition = characterized_product_definition`  
`characterized_definition <-`  
`property_definition.definition`  
`property_definition =>`  
`product_definition_shape <-`  
`shape_aspect.of_shape`  
`shape_aspect`  
`{shape_aspect.description = 'splitter'}`

#### 5.1.6.8 **Hvac\_elbow\_centred**

AIM element: `hvac_component_definition`

Source: 227

Rules: `dependent_instantiable_product_context`  
`product_context_discipline_type_constraint`  
`value_for_application_context`

Reference path: `hvac_component_definition <=`  
`product_definition`  
`{hvac_component_definition`  
`classification_item = hvac_component_definition`  
`classification_item <-`  
`applied_classification_assignment.items[i]`  
`applied_classification_assignment <=`  
`classification_assignment`  
`classification_assignment.assigned_classification ->`  
`[group =>`  
`hvac_fitting_class]`  
`[group`  
`group.name = 'hvac elbow centred']}`  
`{product_definition`  
`product_definition.formation ->`  
`product_definition_formation`  
`product_definition_formation.of_product ->`  
`[product`  
`classification_item = product`  
`classification_item <-`

```

applied_classification_assignment.items[i]
applied_classification_assignment <=
classification_assignment
classification_assignment.assigned_classification ->
(group)
(group <-
group_relationship.related_group
group_relationship
group_relationship.relying_group ->
group)
group.name = 'hvac fitting']
[product
product.frame_of_reference[i] ->
product_context <=
application_context_element
application_context_element.name = 'plant item']]

```

### 5.1.6.8.1 angle

AIM element: [measure\_with\_unit.value\_component]  
[measure\_with\_unit.unit\_component]

Source: 41

Rules: subtype\_mandatory\_shape\_representation

Reference path: hvac\_component\_definition <=  
product\_definition  
characterized\_product\_definition = product\_definition  
characterized\_product\_definition  
characterized\_definition = characterized\_product\_definition  
characterized\_definition <=  
property\_definition.definition  
property\_definition =>  
product\_definition\_shape <=  
shape\_aspect.of\_shape  
[shape\_aspect <=  
shape\_aspect\_relationship.relying\_shape\_aspect]  
[shape\_aspect <=  
shape\_aspect\_relationship.related\_shape\_aspect]  
shape\_aspect\_relationship =>  
dimensional\_location  
dimensional\_characteristic = dimensional\_location  
dimensional\_characteristic <=  
dimensional\_characteristic\_representation.dimension  
dimensional\_characteristic\_representation  
dimensional\_characteristic\_representation.representation ->  
shape\_dimension\_representation <=  
shape\_representation <=  
{representation  
representation.name = 'hvac elbow dimensional shape'}  
representation  
representation.items[i] ->  
representation\_item =>

```

{representation_item.name = 'angle'}
measure_representation_item <=
{measure_with_unit =>
plane_angle_measure_with_unit}
measure_with_unit
[measure_with_unit.value_component]
[measure_with_unit.unit_component]

```

### 5.1.6.8.2 width

AIM element: [measure\_with\_unit.value\_component]  
[measure\_with\_unit.unit\_component]

Source: 41

Rules: subtype\_mandatory\_shape\_representation

Reference path: hvac\_component\_definition <=  
product\_definition  
characterized\_product\_definition = product\_definition  
characterized\_product\_definition  
characterized\_definition = characterized\_product\_definition  
characterized\_definition <=  
property\_definition.definition  
property\_definition =>  
product\_definition\_shape <=  
shape\_aspect.of\_shape  
[shape\_aspect <=  
shape\_aspect\_relationship.relate\_shape\_aspect]  
[shape\_aspect <=  
shape\_aspect\_relationship.related\_shape\_aspect]  
shape\_aspect\_relationship =>  
dimensional\_location  
dimensional\_characteristic = dimensional\_location  
dimensional\_characteristic <=  
dimensional\_characteristic\_representation.dimension  
dimensional\_characteristic\_representation  
dimensional\_characteristic\_representation.representation ->  
shape\_dimension\_representation <=  
shape\_representation <=  
{representation  
representation.name = 'hvac elbow dimensional shape'}  
representation  
representation.items[i] ->  
representation\_item =>  
{representation\_item.name = 'width'}  
measure\_representation\_item <=  
{measure\_with\_unit =>  
length\_measure\_with\_unit}  
measure\_with\_unit  
[measure\_with\_unit.value\_component]  
[measure\_with\_unit.unit\_component]

**5.1.6.8.3 height**

AIM element: [measure\_with\_unit.value\_component]  
[measure\_with\_unit.unit\_component]

Source: 41

Rules: subtype\_mandatory\_shape\_representation

Reference path: hvac\_component\_definition <=  
product\_definition  
characterized\_product\_definition = product\_definition  
characterized\_product\_definition  
characterized\_definition = characterized\_product\_definition  
characterized\_definition <=  
property\_definition.definition  
property\_definition =>  
product\_definition\_shape <=  
shape\_aspect.of\_shape  
[shape\_aspect <=  
shape\_aspect\_relationship.relating\_shape\_aspect]  
[shape\_aspect <=  
shape\_aspect\_relationship.related\_shape\_aspect]  
shape\_aspect\_relationship =>  
dimensional\_location  
dimensional\_characteristic = dimensional\_location  
dimensional\_characteristic <=  
dimensional\_characteristic\_representation.dimension  
dimensional\_characteristic\_representation  
dimensional\_characteristic\_representation.representation ->  
shape\_dimension\_representation <=  
shape\_representation <=  
{representation  
representation.name = 'hvac elbow dimensional shape'}  
representation  
representation.items[i] ->  
representation\_item =>  
{representation\_item.name = 'height'}  
measure\_representation\_item <=  
{measure\_with\_unit =>  
length\_measure\_with\_unit}  
measure\_with\_unit  
[measure\_with\_unit.value\_component]  
[measure\_with\_unit.unit\_component]

**5.1.6.8.4 throat\_radius**

AIM element: [measure\_with\_unit.value\_component]  
[measure\_with\_unit.unit\_component]

Source: 41

Rules: subtype\_mandatory\_shape\_representation

Reference path: hvac\_component\_definition <=  
product\_definition  
characterized\_product\_definition = product\_definition  
characterized\_product\_definition  
characterized\_definition = characterized\_product\_definition  
characterized\_definition <=  
property\_definition.definition  
property\_definition =>  
product\_definition\_shape <=  
shape\_aspect.of\_shape  
[shape\_aspect <=  
shape\_aspect\_relationship.relate\_shape\_aspect]  
[shape\_aspect <=  
shape\_aspect\_relationship.related\_shape\_aspect]  
shape\_aspect\_relationship =>  
dimensional\_location  
dimensional\_characteristic = dimensional\_location  
dimensional\_characteristic <=  
dimensional\_characteristic\_representation.dimension  
dimensional\_characteristic\_representation  
dimensional\_characteristic\_representation.representation ->  
shape\_dimension\_representation <=  
shape\_representation <=  
{representation  
representation.name = 'hvac elbow dimensional shape'}  
representation  
representation.items[i] ->  
representation\_item =>  
{representation\_item.name = 'throat radius'}  
measure\_representation\_item <=  
{measure\_with\_unit =>  
length\_measure\_with\_unit}  
measure\_with\_unit  
[measure\_with\_unit.value\_component]  
[measure\_with\_unit.unit\_component]

#### 5.1.6.8.5 heel\_radius

AIM element: [measure\_with\_unit.value\_component]  
[measure\_with\_unit.unit\_component]

Source: 41

Rules: subtype\_mandatory\_shape\_representation

Reference path: hvac\_component\_definition <=  
product\_definition  
characterized\_product\_definition = product\_definition  
characterized\_product\_definition  
characterized\_definition = characterized\_product\_definition  
characterized\_definition <=  
property\_definition.definition  
property\_definition =>  
product\_definition\_shape <=

```

shape_aspect.of_shape
[shape_aspect <-
shape_aspect_relationship.relating_shape_aspect]
[shape_aspect <-
shape_aspect_relationship.related_shape_aspect]
shape_aspect_relationship =>
dimensional_location
dimensional_characteristic = dimensional_location
dimensional_characteristic <-
dimensional_characteristic_representation.dimension
dimensional_characteristic_representation
dimensional_characteristic_representation.representation ->
shape_dimension_representation <=
shape_representation <=
{representation
representation.name = 'hvac elbow dimensional shape'}
representation
representation.items[i] ->
representation_item =>
{representation_item.name = 'heel radius'}
measure_representation_item <=
{measure_with_unit =>
length_measure_with_unit}
measure_with_unit
[measure_with_unit.value_component]
[measure_with_unit.unit_component]

```

#### 5.1.6.8.6 end\_1\_connector

AIM element: hvac\_connector

Source: 227

Reference path: hvac\_component\_definition <=

```

product_definition
characterized_product_definition = product_definition
characterized_product_definition
characterized_definition = characterized_product_definition
characterized_definition <-
property_definition.definition
property_definition =>
product_definition_shape <-
shape_aspect.of_shape
{shape_aspect
shape_aspect.description = 'end 1'}
shape_aspect =>
hvac_connector

```

#### 5.1.6.8.7 end\_2\_connector

AIM element: hvac\_connector

Source: 227

Reference path: hvac\_component\_definition <=  
product\_definition  
characterized\_product\_definition = product\_definition  
characterized\_product\_definition  
characterized\_definition = characterized\_product\_definition  
characterized\_definition <=  
property\_definition.definition  
property\_definition =>  
product\_definition\_shape <=  
shape\_aspect.of\_shape  
{shape\_aspect  
shape\_aspect.description = 'end 2'}  
shape\_aspect =>  
hvac\_connector

#### 5.1.6.8 hvac\_elbow\_centred to splitter

AIM element: PATH

Reference path: hvac\_component\_definition <=  
product\_definition  
characterized\_product\_definition = product\_definition  
characterized\_product\_definition  
characterized\_definition = characterized\_product\_definition  
characterized\_definition <=  
property\_definition.definition  
property\_definition =>  
product\_definition\_shape <=  
shape\_aspect.of\_shape  
shape\_aspect  
{shape\_aspect.description = 'splitter'}

#### 5.1.6.9 Hvac\_elbow\_mitre

AIM element: hvac\_component\_definition

Source: 227

Rules: dependent\_instantiable\_product\_context  
product\_context\_discipline\_type\_constraint  
value\_for\_application\_context

Reference path: hvac\_component\_definition <=  
product\_definition  
{hvac\_component\_definition  
classification\_item = hvac\_component\_definition  
classification\_item <=  
applied\_classification\_assignment.items[i]  
applied\_classification\_assignment <=  
classification\_assignment

```

classification_assignment.assigned_classification ->
[group =>
hvac_fitting_class]
[group
group.name = 'hvac elbow mitre']]
{product_definition
product_definition.formation ->
product_definition_formation
product_definition_formation.of_product ->
[product
classification_item = product
classification_item <-
applied_classification_assignment.items[i]
applied_classification_assignment <=
classification_assignment
classification_assignment.assigned_classification ->
(group)
(group <-
group_relationship.related_group
group_relationship
group_relationship.relying_group ->
group)
group.name = 'hvac fitting']
[product
product.frame_of_reference[i] ->
product_context <=
application_context_element
application_context_element.name = 'plant item']]

```

### 5.1.6.9.1 angle\_first\_section

AIM element: [measure\_with\_unit.value\_component]  
[measure\_with\_unit.unit\_component]

Source: 41

Rules: subtype\_mandatory\_shape\_representation

Reference path: hvac\_component\_definition <=  
product\_definition  
characterized\_product\_definition = product\_definition  
characterized\_product\_definition  
characterized\_definition = characterized\_product\_definition  
characterized\_definition <-  
property\_definition.definition  
property\_definition =>  
product\_definition\_shape <-  
shape\_aspect.of\_shape  
[shape\_aspect <-  
shape\_aspect\_relationship.relying\_shape\_aspect]  
[shape\_aspect <-  
shape\_aspect\_relationship.related\_shape\_aspect]  
shape\_aspect\_relationship =>  
dimensional\_location

```

dimensional_characteristic = dimensional_location
dimensional_characteristic <-
dimensional_characteristic_representation.dimension
dimensional_characteristic_representation
dimensional_characteristic_representation.representation ->
shape_dimension_representation <=
shape_representation <=
{representation
representation.name = 'hvac elbow dimensional shape'}
representation
representation.items[i] ->
representation_item =>
{representation_item.name = 'angle first section'}
measure_representation_item <=
{measure_with_unit =>
plane_angle_measure_with_unit}
measure_with_unit
[measure_with_unit.value_component]
[measure_with_unit.unit_component]

```

### 5.1.6.9.2 angle\_last\_section

AIM element: [measure\_with\_unit.value\_component]  
[measure\_with\_unit.unit\_component]

Source: 41

Rules: subtype\_mandatory\_shape\_representation

Reference path: hvac\_component\_definition <=  
product\_definition  
characterized\_product\_definition = product\_definition  
characterized\_product\_definition  
characterized\_definition = characterized\_product\_definition  
characterized\_definition <-  
property\_definition.definition  
property\_definition =>  
product\_definition\_shape <-  
shape\_aspect.of\_shape  
[shape\_aspect <-  
shape\_aspect\_relationship.relating\_shape\_aspect]  
[shape\_aspect <-  
shape\_aspect\_relationship.related\_shape\_aspect]  
shape\_aspect\_relationship =>  
dimensional\_location  
dimensional\_characteristic = dimensional\_location  
dimensional\_characteristic <-  
dimensional\_characteristic\_representation.dimension  
dimensional\_characteristic\_representation  
dimensional\_characteristic\_representation.representation ->  
shape\_dimension\_representation <=  
shape\_representation <=  
{representation  
representation.name = 'hvac elbow dimensional shape'}

```

representation
representation.items[i] ->
representation_item =>
{representation_item.name = 'angle last section'}
measure_representation_item <=
{measure_with_unit =>
plane_angle_measure_with_unit}
measure_with_unit
[measure_with_unit.value_component]
[measure_with_unit.unit_component]

```

### 5.1.6.9.3 number\_of\_sections

AIM element: [measure\_with\_unit.value\_component]  
[measure\_with\_unit.unit\_component]

Reference path: hvac\_component\_definition <=  
product\_definition  
characterized\_product\_definition = product\_definition  
characterized\_product\_definition  
characterized\_definition = characterized\_product\_definition  
characterized\_definition <=  
property\_definition.definition  
property\_definition  
represented\_definition = property\_definition  
represented\_definition <=  
property\_definition\_representation.definition  
property\_definition\_representation  
property\_definition\_representation.used\_representation ->  
{representation  
representation.name = 'hvac elbow characteristics'}  
representation  
{representation\_item  
representation\_item.name = 'number of sections'}  
representation\_item =>  
measure\_representation\_item <=  
measure\_with\_unit  
[measure\_with\_unit.value\_component  
{measure\_with\_unit.value\_component ->  
measure\_value  
measure\_value = count\_measure}}]  
[measure\_with\_unit.unit\_component]

### 5.1.6.9.4 offset

AIM element: [measure\_with\_unit.value\_component]  
[measure\_with\_unit.unit\_component]

Source: 41

Rules: subtype\_mandatory\_shape\_representation

Reference path: hvac\_component\_definition <=

```

product_definition
characterized_product_definition = product_definition
characterized_product_definition
characterized_definition = characterized_product_definition
characterized_definition <-
property_definition.definition
property_definition =>
product_definition_shape <-
shape_aspect.of_shape
[shape_aspect <-
shape_aspect_relationship.relating_shape_aspect]
[shape_aspect <-
shape_aspect_relationship.related_shape_aspect]
shape_aspect_relationship =>
dimensional_location
dimensional_characteristic = dimensional_location
dimensional_characteristic <-
dimensional_characteristic_representation.dimension
dimensional_characteristic_representation
dimensional_characteristic_representation.representation ->
shape_dimension_representation <=
shape_representation <=
{representation
representation.name = 'hvac elbow dimensional shape'}
representation
representation.items[i] ->
representation_item =>
{representation_item.name = 'offset'}
measure_representation_item <=
{measure_with_unit =>
length_measure_with_unit}
measure_with_unit
[measure_with_unit.value_component]
[measure_with_unit.unit_component]

```

#### 5.1.6.9.5 length

AIM element: [measure\_with\_unit.value\_component]  
[measure\_with\_unit.unit\_component]

Source: 41

Rules: subtype\_mandatory\_shape\_representation

Reference path: hvac\_component\_definition <=

```

product_definition
characterized_product_definition = product_definition
characterized_product_definition
characterized_definition = characterized_product_definition
characterized_definition <-
property_definition.definition
property_definition =>
product_definition_shape <-
shape_aspect.of_shape

```

```

[shape_aspect <-
shape_aspect_relationship.relateing_shape_aspect]
[shape_aspect <-
shape_aspect_relationship.related_shape_aspect]
shape_aspect_relationship =>
dimensional_location
dimensional_characteristic = dimensional_location
dimensional_characteristic <-
dimensional_characteristic_representation.dimension
dimensional_characteristic_representation
dimensional_characteristic_representation.representation ->
shape_dimension_representation <=
shape_representation <=
{representation
representation.name = 'hvac elbow dimensional shape'}
representation
representation.items[i] ->
representation_item =>
{representation_item.name = 'length'}
measure_representation_item <=
{measure_with_unit =>
length_measure_with_unit}
measure_with_unit
[measure_with_unit.value_component]
[measure_with_unit.unit_component]

```

#### 5.1.6.9.6 throat\_radius

AIM element: [measure\_with\_unit.value\_component]  
[measure\_with\_unit.unit\_component]

Source: 41

Rules: subtype\_mandatory\_shape\_representation

Reference path: hvac\_component\_definition <=

```

product_definition
characterized_product_definition = product_definition
characterized_product_definition
characterized_definition = characterized_product_definition
characterized_definition <-
property_definition.definition
property_definition =>
product_definition_shape <-
shape_aspect.of_shape
[shape_aspect <-
shape_aspect_relationship.relateing_shape_aspect]
[shape_aspect <-
shape_aspect_relationship.related_shape_aspect]
shape_aspect_relationship =>
dimensional_location
dimensional_characteristic = dimensional_location
dimensional_characteristic <-
dimensional_characteristic_representation.dimension

```

```

dimensional_characteristic_representation
dimensional_characteristic_representation.representation ->
shape_dimension_representation <=
shape_representation <=
{representation
representation.name = 'hvac elbow dimensional shape'}
representation
representation.items[i] ->
representation_item =>
{representation_item.name = 'throat radius'}
measure_representation_item <=
{measure_with_unit =>
length_measure_with_unit}
measure_with_unit
[measure_with_unit.value_component]
[measure_with_unit.unit_component]

```

### 5.1.6.9.7 heel\_radius

AIM element: [measure\_with\_unit.value\_component]  
[measure\_with\_unit.unit\_component]

Source: 41

Rules: subtype\_mandatory\_shape\_representation

Reference path: hvac\_component\_definition <=  
product\_definition  
characterized\_product\_definition = product\_definition  
characterized\_product\_definition  
characterized\_definition = characterized\_product\_definition  
characterized\_definition <=  
property\_definition.definition  
property\_definition =>  
product\_definition\_shape <=  
shape\_aspect.of\_shape  
[shape\_aspect <=  
shape\_aspect\_relationship.relating\_shape\_aspect]  
[shape\_aspect <=  
shape\_aspect\_relationship.related\_shape\_aspect]  
shape\_aspect\_relationship =>  
dimensional\_location  
dimensional\_characteristic = dimensional\_location  
dimensional\_characteristic <=  
dimensional\_characteristic\_representation.dimension  
dimensional\_characteristic\_representation  
dimensional\_characteristic\_representation.representation ->  
shape\_dimension\_representation <=  
shape\_representation <=  
{representation  
representation.name = 'hvac elbow dimensional shape'}  
representation  
representation.items[i] ->  
representation\_item =>

```

{representation_item.name = 'heel radius'}
measure_representation_item <=
{measure_with_unit =>
length_measure_with_unit}
measure_with_unit
[measure_with_unit.value_component]
[measure_with_unit.unit_component]

```

#### 5.1.6.9.8 end\_1\_connector

AIM element: hvac\_connector

Source: 227

Reference path: hvac\_component\_definition <=

```

product_definition
characterized_product_definition = product_definition
characterized_product_definition
characterized_definition = characterized_product_definition
characterized_definition <-
property_definition.definition
property_definition =>
product_definition_shape <-
shape_aspect.of_shape
{shape_aspect
shape_aspect.description = 'end 1'}
shape_aspect =>
hvac_connector

```

#### 5.1.6.9.9 end\_2\_connector

AIM element: hvac\_connector

Source: 227

Reference path: hvac\_component\_definition <=

```

product_definition
characterized_product_definition = product_definition
characterized_product_definition
characterized_definition = characterized_product_definition
characterized_definition <-
property_definition.definition
property_definition =>
product_definition_shape <-
shape_aspect.of_shape
{shape_aspect
shape_aspect.description = 'end 2'}
shape_aspect =>
hvac_connector

```

**5.1.6.9.10 sweep\_angle**

AIM element: [measure\_with\_unit.value\_component]  
[measure\_with\_unit.unit\_component]

Source: 41

Rules: subtype\_mandatory\_shape\_representation

Reference path: hvac\_component\_definition <=  
product\_definition  
characterized\_product\_definition = product\_definition  
characterized\_product\_definition  
characterized\_definition = characterized\_product\_definition  
characterized\_definition <=  
property\_definition.definition  
property\_definition =>  
product\_definition\_shape <=  
shape\_aspect.of\_shape  
[shape\_aspect <=  
shape\_aspect\_relationship.relating\_shape\_aspect]  
[shape\_aspect <=  
shape\_aspect\_relationship.related\_shape\_aspect]  
shape\_aspect\_relationship =>  
dimensional\_location  
dimensional\_characteristic = dimensional\_location  
dimensional\_characteristic <=  
dimensional\_characteristic\_representation.dimension  
dimensional\_characteristic\_representation  
dimensional\_characteristic\_representation.representation ->  
shape\_dimension\_representation <=  
shape\_representation <=  
{representation  
representation.name = 'hvac elbow dimensional shape'}  
representation  
representation.items[i] ->  
representation\_item =>  
{representation\_item.name = 'sweep\_angle'}  
measure\_representation\_item <=  
{measure\_with\_unit =>  
plane\_angle\_measure\_with\_unit}  
measure\_with\_unit  
[measure\_with\_unit.value\_component]  
[measure\_with\_unit.unit\_component]

**5.1.6.9.11 hvac\_elbow\_mitre to splitter**

AIM element: PATH

Reference path: hvac\_component\_definition <=  
product\_definition  
characterized\_product\_definition = product\_definition  
characterized\_product\_definition  
characterized\_definition = characterized\_product\_definition

```

characterized_definition <-
property_definition.definition
property_definition =>
product_definition_shape <-
shape_aspect.of_shape
shape_aspect
{shape_aspect.description = 'splitter'}

```

### 5.1.6.10 Hvac\_end\_fitting

AIM element: hvac\_component\_definition

Source: 227

Rules: dependent\_instantiable\_product\_context  
product\_context\_discipline\_type\_constraint  
value\_for\_application\_context

Reference path: hvac\_component\_definition <=  
product\_definition  
{hvac\_component\_definition  
classification\_item = hvac\_component\_definition  
classification\_item <-  
applied\_classification\_assignment.items[i]  
applied\_classification\_assignment <=  
classification\_assignment  
classification\_assignment.assigned\_classification ->  
[group =>  
hvac\_fitting\_class]  
[group  
group.name = 'hvac end fitting']}  
{product\_definition  
product\_definition.formation ->  
product\_definition\_formation  
product\_definition\_formation.of\_product ->  
[product  
classification\_item = product  
classification\_item <-  
applied\_classification\_assignment.items[i]  
applied\_classification\_assignment <=  
classification\_assignment  
classification\_assignment.assigned\_classification ->  
(group)  
(group <-  
group\_relationship.related\_group  
group\_relationship  
group\_relationship.relatng\_group ->  
group)  
group.name = 'hvac fitting']  
[product  
product.frame\_of\_reference[i] ->  
product\_context <=

```

application_context_element
application_context_element.name = 'plant item']})

```

#### 5.1.6.10.1 opening\_type

AIM element: group.name

Source: 41

Reference path:

```

shape_aspect
classification_item = shape_aspect
classification_item <-
applied_classification_assignment.items[i]
applied_classification_assignment <=
{classification_assignment
classification_assignment.role ->
classification_role
classification_role.name = 'hvac end fitting opening type classification'}
classification_assignment
classification_assignment.assigned_classification ->
group
group.name

```

#### 5.1.6.10.2 end\_1\_connector

AIM element: hvac\_connector

Source: 227

Reference path:

```

hvac_component_definition <=
product_definition
characterized_product_definition = product_definition
characterized_product_definition
characterized_definition = characterized_product_definition
characterized_definition <-
property_definition.definition
property_definition =>
product_definition_shape <-
shape_aspect.of_shape
{shape_aspect
shape_aspect.description = 'end 1'}
shape_aspect =>
hvac_connector

```

#### 5.1.6.11 Hvac\_equipment

AIM element: product

Source: 41

Rules:

```

dependent_instantiable_product_context
product_context_discipline_type_constraint
value_for_application_context

```

Reference path: `{[product  
classification_item = product  
classification_item <-  
applied_classification_assignment.items[i]  
applied_classification_assignment <=  
classification_assignment  
classification_assignment.assigned_classification ->  
[group  
group.name = 'hvac equipment']  
[group <-  
group_relationship.related_group  
{group_relationship  
group_relationship.name = 'usage classification'}  
group_relationship  
group_relationship.relying_group ->  
group  
group.name = 'hvac component']]  
[product  
product.frame_of_reference[i] ->  
product_context<=  
application_context_element  
application_context_element.name = 'plant item']]}`

#### 5.1.6.11.1 hvac\_equipment to hvac\_flow\_control\_device

AIM element: PATH

Reference path: `product <-  
product_definition_formation.of_product  
product_definition_formation <-  
product_definition.formation  
product_definition <-  
product_definition_relationship.relying_product_definition  
product_definition_relationship  
{product_definition_relationship.name = 'flow control'}  
product_definition_relationship.related_product_definition ->  
product_definition  
product_definition.formation ->  
product_definition_formation  
product_definition_formation.of_product ->  
product`

#### 5.1.6.12 Hvac\_fitting

AIM element: product

Source: 41

Rules: `dependent_instantiable_product_context  
product_context_discipline_type_constraint  
value_for_application_context`

Reference path: {[product  
classification\_item = product  
classification\_item <-  
applied\_classification\_assignment.items[i]  
applied\_classification\_assignment <=  
classification\_assignment  
classification\_assignment.assigned\_classification ->  
[group  
group.name = 'hvac fitting']  
[group <-  
group\_relationship.related\_group  
{group\_relationship  
group\_relationship.name = 'usage classification'}  
group\_relationship  
group\_relationship.relying\_group ->  
group  
group.name = 'hvac component']]  
[product  
product.frame\_of\_reference[i] ->  
product\_context <=  
application\_context\_element  
application\_context\_element.name = 'plant item']]}

### 5.1.6.13 Hvac\_flow\_control\_device

AIM element: product

Source: 41

Rules: dependent\_instantiable\_product\_context  
product\_context\_discipline\_type\_constraint  
value\_for\_application\_context

Reference path: {[product  
classification\_item = product  
classification\_item <-  
applied\_classification\_assignment.items[i]  
applied\_classification\_assignment <=  
classification\_assignment  
classification\_assignment.assigned\_classification ->  
[group  
group.name = 'hvac flow control device']  
[group <-  
group\_relationship.related\_group  
{group\_relationship  
group\_relationship.name = 'usage classification'}  
group\_relationship  
group\_relationship.relying\_group ->  
group  
group.name = 'hvac component']]  
[product

```

product.frame_of_reference[i] ->
product_context <=
application_context_element
application_context_element.name = 'plant item'}}

```

### 5.1.6.13.1 flow\_control\_device\_id

AIM element: product.id

Source: 41

### 5.1.6.13.2 control\_device\_type

AIM element: group.name

Source: 41

Reference path:

```

product
classification_item = product
classification_item <-
applied_classification_assignment.items[i]
applied_classification_assignment <=
{classification_assignment
classification_assignment.role ->
classification_role
classification_role.name = 'hvac access opening type classification'}
classification_assignment
classification_assignment.assigned_classification ->
group
group.name

```

### 5.1.6.13.3 end\_1\_connector

AIM element: hvac\_connector

Source: 227

Reference path:

```

product <-
product_definition_formation.of_product
product_definition_formation <-
product_definition.formation
product_definition
characterized_product_definition = product_definition
characterized_product_definition
characterized_definition = characterized_product_definition
characterized_definition <-
property_definition.definition
property_definition =>
product_definition_shape <-
shape_aspect.of_shape
{shape_aspect
shape_aspect.description = 'end 1'}

```

```

shape_aspect =>
hvac_connector

```

#### 5.1.6.13.4 end\_2\_connector

AIM element: hvac\_connector

Source: 227

Reference path:

```

product <-
product_definition_formation.of_product
product_definition_formation <-
product_definition.formation
product_definition
characterized_product_definition = product_definition
characterized_product_definition
characterized_definition = characterized_product_definition
characterized_definition <-
property_definition.definition
property_definition =>
product_definition_shape <-
shape_aspect.of_shape
{shape_aspect
shape_aspect.description = 'end 2'}
shape_aspect =>
hvac_connector

```

#### 5.1.6.13.5 control\_point\_units

AIM element: measure\_with\_unit.unit\_component

Source: 41

Reference path:

```

product <-
product_definition_formation.of_product
product_definition_formation <-
product_definition.formation
product_definition
characterized_product_definition = product_definition
characterized_product_definition
characterized_definition = characterized_product_definition
characterized_definition <-
property_definition.definition
property_definition <-
property_definition_representation.definition
property_definition_representation
property_definition_representation.using_representation ->
representation
{representation.name = 'flow control device characteristics'}
representation.items[i] ->
representation_item =>
{(representation_item.name = 'control point nominal value')
(representation_item.name = 'control point maximum value')}

```

```
(representation_item.name = 'control point minimum value')
(representation_item.name = 'control point set point value')
measure_representation_item <=
measure_with_unit
measure_with_unit.unit_component
```

### 5.1.6.13.6 control\_point\_nominal\_value

AIM element: measure\_with\_unit.value\_component

Source: 41

Reference path:

```
product <-
product_definition_formation.of_product
product_definition_formation <-
product_definition.formation
product_definition
characterized_product_definition = product_definition
characterized_product_definition
characterized_definition = characterized_product_definition
characterized_definition <-
property_definition.definition
property_definition <-
property_definition_representation.definition
property_definition_representation
property_definition_representation.using_representation ->
representation
{representation.name = 'flow control device characteristics'}
representation.items[i] ->
representation_item =>
{representation_item.name = 'control point nominal value'}
measure_representation_item <=
measure_with_unit
measure_with_unit.value_component
```

### 5.1.6.13.7 control\_point\_min\_value

AIM element: measure\_with\_unit.value\_component

Source: 41

Reference path:

```
product <-
product_definition_formation.of_product
product_definition_formation <-
product_definition.formation
product_definition
characterized_product_definition = product_definition
characterized_product_definition
characterized_definition = characterized_product_definition
characterized_definition <-
property_definition.definition
property_definition <-
property_definition_representation.definition
```

```

property_definition_representation
property_definition_representation.using_representation ->
representation
{representation.name = 'flow control device characteristics'}
representation.items[i] ->
representation_item =>
{representation_item.name = 'control point minimum value'}
measure_representation_item <=
measure_with_unit
measure_with_unit.value_component

```

#### 5.1.6.13.8 control\_point\_max\_value

AIM element: measure\_with\_unit.value\_component

Source: 41

Reference path:

```

product <-
product_definition_formation.of_product
product_definition_formation <-
product_definition.formation
product_definition
characterized_product_definition = product_definition
characterized_product_definition
characterized_definition = characterized_product_definition
characterized_definition <-
property_definition.definition
property_definition <-
property_definition_representation.definition
property_definition_representation
property_definition_representation.using_representation ->
representation
{representation.name = 'flow control device characteristics'}
representation.items[i] ->
representation_item =>
{representation_item.name = 'control point maximum value'}
measure_representation_item <=
measure_with_unit
measure_with_unit.value_component

```

#### 5.1.6.13.9 control\_point\_set\_point\_value

AIM element: measure\_with\_unit.value\_component

Source: 41

Reference path:

```

product <-
product_definition_formation.of_product
product_definition_formation <-
product_definition.formation
product_definition
characterized_product_definition = product_definition
characterized_product_definition

```

```

characterized_definition = characterized_product_definition
characterized_definition <-
property_definition.definition
property_definition <-
property_definition_representation.definition
property_definition_representation
property_definition_representation.using_representation ->
representation
{representation.name = 'flow control device characteristics'}
representation.items[i] ->
representation_item =>
{representation_item.name = 'control point set point value'}
measure_representation_item <=
measure_with_unit
measure_with_unit.value_component

```

#### 5.1.6.14 Hvac\_gasket

AIM element: hvac\_component\_definition

Source: 227

Rules: dependent\_instantiable\_product\_context  
product\_context\_discipline\_type\_constraint  
value\_for\_application\_context

Reference path: hvac\_component\_definition <=

```

product_definition
{hvac_component_definition
classification_item = hvac_component_definition
classification_item <-
applied_classification_assignment.items[i]
applied_classification_assignment <=
classification_assignment
classification_assignment.assigned_classification ->
[group =>
hvac_fitting_class]
[group
group.name = 'hvac gasket']}]
{product_definition
product_definition_formation ->
product_definition_formation
product_definition_formation.of_product ->
[product
classification_item = product
classification_item <-
applied_classification_assignment.items[i]
applied_classification_assignment <=
classification_assignment
classification_assignment.assigned_classification ->
(group)
(group <-
group_relationship.related_group

```

```

group_relationship
group_relationship.relying_group ->
group)
group.name = 'hvac fitting']
[product
product.frame_of_reference[i] ->
product_context <=
application_context_element
application_context_element.name = 'plant item']))

```

#### 5.1.6.14.1 gasket\_thickness

AIM element: [measure\_with\_unit.value\_component]  
[measure\_with\_unit.unit\_component]

Source: 41

Rules: subtype\_mandatory\_shape\_representation

Reference path: hvac\_component\_definition <=  
product\_definition  
characterized\_product\_definition = product\_definition  
characterized\_product\_definition  
characterized\_definition = characterized\_product\_definition  
characterized\_definition <=  
property\_definition.definition  
property\_definition =>  
product\_definition\_shape <=  
shape\_aspect.of\_shape  
[shape\_aspect <=  
shape\_aspect\_relationship.relying\_shape\_aspect]  
[shape\_aspect <=  
shape\_aspect\_relationship.related\_shape\_aspect]  
shape\_aspect\_relationship =>  
dimensional\_location  
dimensional\_characteristic = dimensional\_location  
dimensional\_characteristic <=  
dimensional\_characteristic\_representation.dimensional  
dimensional\_characteristic\_representation  
dimensional\_characteristic\_representation.representation ->  
shape\_dimension\_representation <=  
shape\_representation <=  
{representation  
representation.name = 'hvac gasket dimensional shape'}  
representation  
representation.items[i] ->  
representation\_item =>  
{representation\_item.name = 'thickness'}  
measure\_representation\_item <=  
{measure\_with\_unit =>  
length\_measure\_with\_unit}  
measure\_with\_unit  
[measure\_with\_unit.value\_component]

[measure\_with\_unit.unit\_component]

#### 5.1.6.14.2 end\_1\_connector

AIM element: hvac\_connector

Source: 227

Reference path: hvac\_component\_definition <=  
 product\_definition  
 characterized\_product\_definition = product\_definition  
 characterized\_product\_definition  
 characterized\_definition = characterized\_product\_definition  
 characterized\_definition <=  
 property\_definition.definition  
 property\_definition =>  
 product\_definition\_shape <=  
 shape\_aspect.of\_shape  
 {shape\_aspect  
 shape\_aspect.description = 'end 1'}  
 shape\_aspect =>  
 hvac\_connector

#### 5.1.6.14.3 end\_2\_connector

AIM element: hvac\_connector

Source: 227

Reference path: hvac\_component\_definition <=  
 product\_definition  
 characterized\_product\_definition = product\_definition  
 characterized\_product\_definition  
 characterized\_definition = characterized\_product\_definition  
 characterized\_definition <=  
 property\_definition.definition  
 property\_definition =>  
 product\_definition\_shape <=  
 shape\_aspect.of\_shape  
 {shape\_aspect  
 shape\_aspect.description = 'end 2'}  
 shape\_aspect =>  
 hvac\_connector

#### 5.1.6.15 Hvac\_instrument

AIM element: product

Source: 41

Rules: dependent\_instantiable\_product\_context  
 product\_context\_discipline\_type\_constraint  
 value\_for\_application\_context

Reference path: `{[product  
classification_item = product  
classification_item <-  
applied_classification_assignment.items[i]  
applied_classification_assignment <=  
classification_assignment  
classification_assignment.assigned_classification ->  
[group  
group.name = 'hvac instrument']  
[group <-  
group_relationship.related_group  
{group_relationship  
group_relationship.name = 'usage classification'}  
group_relationship  
group_relationship.relying_group ->  
group  
group.name = 'hvac component']]  
[product  
product.frame_of_reference[i] ->  
product_context <=  
application_context_element  
application_context_element.name = 'plant item']]}`

#### **5.1.6.15.1 instrument\_id**

AIM element: `product.id`

Source: 41

#### **5.1.6.15.2 units**

AIM element: `measure_with_unit.unit_component`

Source: 41

Reference path: `product <-  
product_definition_formation.of_product  
product_definition_formation <-  
product_definition.formation  
product_definition  
characterized_product_definition = product_definition  
characterized_product_definition  
characterized_definition = characterized_product_definition  
characterized_definition <-  
property_definition.definition  
property_definition <-  
property_definition_representation.definition  
property_definition_representation  
property_definition_representation.using_representation ->  
representation  
{representation.name = 'hvac instrument characteristics'}`

```

representation.items[i] ->
representation_item =>
{(representation_item.name = 'low range')
(representation_item.name = 'high range')
(representation_item.name = 'low alarm')
(representation_item.name = 'high alarm')}
measure_representation_item <=
measure_with_unit
measure_with_unit.unit_component

```

### 5.1.6.15.3 low\_range

AIM element: measure\_with\_unit.value\_component

Source: 41

Reference path:

```

product <-
product_definition_formation.of_product
product_definition_formation <-
product_definition.formation
product_definition
characterized_product_definition = product_definition
characterized_product_definition
characterized_definition = characterized_product_definition
characterized_definition <-
property_definition.definition
property_definition <-
property_definition_representation.definition
property_definition_representation
property_definition_representation.using_representation ->
representation
{representation.name = 'hvac instrument characteristics'}
representation.items[i] ->
representation_item =>
{representation_item.name = 'low range'}
measure_representation_item <=
measure_with_unit
measure_with_unit.value_component

```

### 5.1.6.15.4 high\_range

AIM element: measure\_with\_unit.value\_component

Source: 41

Reference path:

```

product <-
product_definition_formation.of_product
product_definition_formation <-
product_definition.formation
product_definition
characterized_product_definition = product_definition
characterized_product_definition
characterized_definition = characterized_product_definition

```

```

characterized_definition <-
property_definition.definition
property_definition <-
property_definition_representation.definition
property_definition_representation
property_definition_representation.using_representation ->
representation
{representation.name = 'hvac instrument characteristics'}
representation.items[i] ->
representation_item =>
{representation_item.name = 'high range'}
measure_representation_item <=
measure_with_unit
measure_with_unit.value_component

```

### 5.1.6.15.5 type

AIM element: descriptive\_representation\_item.description

Source: 45

Reference path:

```

product <-
product_definition_formation.of_product
product_definition_formation <-
product_definition.formation
product_definition
characterized_product_definition = product_definition
characterized_product_definition
characterized_definition = characterized_product_definition
characterized_definition <-
property_definition.definition
property_definition
represented_definition = property_definition
represented_definition <-
property_definition_representation.definition
property_definition_representation
property_definition_representation.used_representation ->
representation
{representation.name = 'hvac instrument characteristics'}
representation.items[i] ->
{representation_item
representation_item.name = 'type'}
representation_item =>
descriptive_representation_item
descriptive_representation_item.description

```

### 5.1.6.15.6 parameter\_measured

AIM element: descriptive\_representation\_item.description

Source: 45

Reference path: product <-

```

product_definition_formation.of_product
product_definition_formation <-
product_definition.formation
product_definition
characterized_product_definition = product_definition
characterized_product_definition
characterized_definition = characterized_product_definition
characterized_definition <-
property_definition.definition
property_definition
represented_definition = property_definition
represented_definition <-
property_definition_representation.definition
property_definition_representation
property_definition_representation.used_representation ->
representation
{representation.name = 'hvac instrument characteristics'}
representation.items[i] ->
{representation_item
representation_item.name = 'parameter measured'}
representation_item =>
descriptive_representation_item
descriptive_representation_item.description

```

#### 5.1.6.15.7 low\_alarm

AIM element:      measure\_with\_unit.value\_component

Source:            41

Reference path:

```

product <-
product_definition_formation.of_product
product_definition_formation <-
product_definition.formation
product_definition
characterized_product_definition = product_definition
characterized_product_definition
characterized_definition = characterized_product_definition
characterized_definition <-
property_definition.definition
property_definition <-
property_definition_representation.definition
property_definition_representation
property_definition_representation.using_representation ->
representation
{representation.name = 'hvac instrument characteristics'}
representation.items[i] ->
representation_item =>
{representation_item.name = 'low alarm'}
measure_representation_item <=
measure_with_unit
measure_with_unit.value_component

```

**5.1.6.15.8 high\_alarm**

AIM element: measure\_with\_unit.value\_component

Source: 41

Reference path: product <-  
 product\_definition\_formation.of\_product  
 product\_definition\_formation <-  
 product\_definition.formation  
 product\_definition  
 characterized\_product\_definition = product\_definition  
 characterized\_product\_definition  
 characterized\_definition = characterized\_product\_definition  
 characterized\_definition <-  
 property\_definition.definition  
 property\_definition <-  
 property\_definition\_representation.definition  
 property\_definition\_representation  
 property\_definition\_representation.using\_representation ->  
 representation  
 {representation.name = 'hvac instrument characteristics'}  
 representation.items[i] ->  
 representation\_item =>  
 {representation\_item.name = 'high alarm'}  
 measure\_representation\_item <=  
 measure\_with\_unit  
 measure\_with\_unit.value\_component

**5.1.6.15.9 nameplate\_inscription**

AIM element: descriptive\_representation\_item.description

Source: 45

Reference path: product <-  
 product\_definition\_formation.of\_product  
 product\_definition\_formation <-  
 product\_definition.formation  
 product\_definition  
 characterized\_product\_definition = product\_definition  
 characterized\_product\_definition  
 characterized\_definition = characterized\_product\_definition  
 characterized\_definition <-  
 property\_definition.definition  
 property\_definition  
 represented\_definition = property\_definition  
 represented\_definition <-  
 property\_definition\_representation.definition  
 property\_definition\_representation  
 property\_definition\_representation.used\_representation ->  
 representation  
 {representation.name = 'hvac instrument characteristics'}  
 representation.items[i] ->

```

{representation_item
representation_item.name = 'nameplate inscription'}
representation_item =>
descriptive_representation_item
descriptive_representation_item.description

```

### 5.1.6.15.10 divisions

AIM element: descriptive\_representation\_item.description

Source: 45

Reference path:

```

product <-
product_definition_formation.of_product
product_definition_formation <-
product_definition.formation
product_definition
characterized_product_definition = product_definition
characterized_product_definition
characterized_definition = characterized_product_definition
characterized_definition <-
property_definition.definition
property_definition
represented_definition = property_definition
represented_definition <-
property_definition_representation.definition
property_definition_representation
property_definition_representation.used_representation ->
representation
{representation.name = 'hvac instrument characteristics'}
representation.items[i] ->
{representation_item
representation_item.name = 'divisions'}
representation_item =>
descriptive_representation_item
descriptive_representation_item.description

```

### 5.1.6.15.11 hvac\_instrument to hvac\_flow\_control\_device

AIM element: PATH

Reference path:

```

product <-
product_definition_formation.of_product
product_definition_formation <-
product_definition.formation
product_definition <-
product_definition_relationship.relying_product_definition
product_definition_relationship
{product_definition_relationship.name = 'data provision'}
product_definition_relationship.related_product_definition ->
product_definition
product_definition.formation ->
product_definition_formation

```

product\_definition\_formation.of\_product ->  
product

### 5.1.6.16 Hvac\_offset\_centred

AIM element: hvac\_component\_definition

Source: 227

Rules: dependent\_instantiable\_product\_context  
product\_context\_discipline\_type\_constraint  
value\_for\_application\_context

Reference path: hvac\_component\_definition <=  
product\_definition  
{hvac\_component\_definition  
classification\_item = hvac\_component\_definition  
classification\_item <=  
applied\_classification\_assignment.items[i]  
applied\_classification\_assignment <=  
classification\_assignment  
classification\_assignment.assigned\_classification ->  
[group =>  
hvac\_fitting\_class]  
[group  
group.name = 'hvac offset centred']}  
{product\_definition  
product\_definition.formation ->  
product\_definition\_formation  
product\_definition\_formation.of\_product ->  
[product  
classification\_item = product  
classification\_item <=  
applied\_classification\_assignment.items[i]  
applied\_classification\_assignment <=  
classification\_assignment  
classification\_assignment.assigned\_classification ->  
(group)  
(group <=  
group\_relationship.related\_group  
group\_relationship  
group\_relationship.relating\_group ->  
group)  
group.name = 'hvac fitting']  
[product  
product.frame\_of\_reference[i] ->  
product\_context <=  
application\_context\_element  
application\_context\_element.name = 'plant item']})

**5.1.6.16.1 angle**

AIM element: [measure\_with\_unit.value\_component]  
[measure\_with\_unit.unit\_component]

Source: 41

Rules: subtype\_mandatory\_shape\_representation

Reference path: hvac\_component\_definition <=  
product\_definition  
characterized\_product\_definition = product\_definition  
characterized\_product\_definition  
characterized\_definition = characterized\_product\_definition  
characterized\_definition <=  
property\_definition.definition  
property\_definition =>  
product\_definition\_shape <=  
shape\_aspect.of\_shape  
[shape\_aspect <=  
shape\_aspect\_relationship.relate\_shape\_aspect]  
[shape\_aspect <=  
shape\_aspect\_relationship.related\_shape\_aspect]  
shape\_aspect\_relationship =>  
dimensional\_location  
dimensional\_characteristic = dimensional\_location  
dimensional\_characteristic <=  
dimensional\_characteristic\_representation.dimension  
dimensional\_characteristic\_representation  
dimensional\_characteristic\_representation.representation ->  
shape\_dimension\_representation <=  
shape\_representation <=  
{representation  
representation.name = 'hvac offset centred dimensional shape'}  
representation  
representation.items[i] ->  
representation\_item =>  
{representation\_item.name = 'angle'}  
measure\_representation\_item <=  
{measure\_with\_unit =>  
plane\_angle\_measure\_with\_unit}  
measure\_with\_unit  
[measure\_with\_unit.value\_component]  
[measure\_with\_unit.unit\_component]

**5.1.6.16.2 offset**

AIM element: [measure\_with\_unit.value\_component]  
[measure\_with\_unit.unit\_component]

Source: 41

Rules: subtype\_mandatory\_shape\_representation

Reference path: hvac\_component\_definition <=  
product\_definition  
characterized\_product\_definition = product\_definition  
characterized\_product\_definition  
characterized\_definition = characterized\_product\_definition  
characterized\_definition <=  
property\_definition.definition  
property\_definition =>  
product\_definition\_shape <=  
shape\_aspect.of\_shape  
[shape\_aspect <=  
shape\_aspect\_relationship.relate\_shape\_aspect]  
[shape\_aspect <=  
shape\_aspect\_relationship.related\_shape\_aspect]  
shape\_aspect\_relationship =>  
dimensional\_location  
dimensional\_characteristic = dimensional\_location  
dimensional\_characteristic <=  
dimensional\_characteristic\_representation.dimension  
dimensional\_characteristic\_representation  
dimensional\_characteristic\_representation.representation ->  
shape\_dimension\_representation <=  
shape\_representation <=  
{representation  
representation.name = 'hvac offset centred dimensional shape'}  
representation  
representation.items[i] ->  
representation\_item =>  
{representation\_item.name = 'offset'}  
measure\_representation\_item <=  
{measure\_with\_unit =>  
length\_measure\_with\_unit}  
measure\_with\_unit  
[measure\_with\_unit.value\_component]  
[measure\_with\_unit.unit\_component]

### 5.1.6.16.3 length

AIM element: [measure\_with\_unit.value\_component]  
[measure\_with\_unit.unit\_component]

Source: 41

Rules: subtype\_mandatory\_shape\_representation

Reference path: hvac\_component\_definition <=  
product\_definition  
characterized\_product\_definition = product\_definition  
characterized\_product\_definition  
characterized\_definition = characterized\_product\_definition  
characterized\_definition <=  
property\_definition.definition  
property\_definition =>  
product\_definition\_shape <=

```

shape_aspect.of_shape
[shape_aspect <-
shape_aspect_relationship.relating_shape_aspect]
[shape_aspect <-
shape_aspect_relationship.related_shape_aspect]
shape_aspect_relationship =>
dimensional_location
dimensional_characteristic = dimensional_location
dimensional_characteristic <-
dimensional_characteristic_representation.dimension
dimensional_characteristic_representation
dimensional_characteristic_representation.representation ->
shape_dimension_representation <=
shape_representation <=
{representation
representation.name = 'hvac offset centred dimensional shape'}
representation
representation.items[i] ->
representation_item =>
{representation_item.name = 'length'}
measure_representation_item <=
{measure_with_unit =>
length_measure_with_unit}
measure_with_unit
[measure_with_unit.value_component]
[measure_with_unit.unit_component]

```

#### 5.1.6.16.4 throat\_radius

AIM element: [measure\_with\_unit.value\_component]  
[measure\_with\_unit.unit\_component]

Source: 41

Rules: subtype\_mandatory\_shape\_representation

Reference path: hvac\_component\_definition <=  
product\_definition  
characterized\_product\_definition = product\_definition  
characterized\_product\_definition  
characterized\_definition = characterized\_product\_definition  
characterized\_definition <-  
property\_definition.definition  
property\_definition =>  
product\_definition\_shape <-  
shape\_aspect.of\_shape  
[shape\_aspect <-  
shape\_aspect\_relationship.relating\_shape\_aspect]  
[shape\_aspect <-  
shape\_aspect\_relationship.related\_shape\_aspect]  
shape\_aspect\_relationship =>  
dimensional\_location  
dimensional\_characteristic = dimensional\_location  
dimensional\_characteristic <-

```

dimensional_characteristic_representation.dimension
dimensional_characteristic_representation
dimensional_characteristic_representation.representation ->
shape_dimension_representation <=
shape_representation <=
{representation
representation.name = 'hvac offset centred dimensional shape'}
representation
representation.items[i] ->
representation_item =>
{representation_item.name = 'throat radius'}
measure_representation_item <=
{measure_with_unit =>
length_measure_with_unit}
measure_with_unit
[measure_with_unit.value_component]
[measure_with_unit.unit_component]

```

### 5.1.6.16.5 heel\_radius

AIM element: [measure\_with\_unit.value\_component]  
[measure\_with\_unit.unit\_component]

Source: 41

Rules: subtype\_mandatory\_shape\_representation

Reference path: hvac\_component\_definition <=  
product\_definition  
characterized\_product\_definition = product\_definition  
characterized\_product\_definition  
characterized\_definition = characterized\_product\_definition  
characterized\_definition <=  
property\_definition.definition  
property\_definition =>  
product\_definition\_shape <=  
shape\_aspect.of\_shape  
[shape\_aspect <=  
shape\_aspect\_relationship.relating\_shape\_aspect]  
[shape\_aspect <=  
shape\_aspect\_relationship.related\_shape\_aspect]  
shape\_aspect\_relationship =>  
dimensional\_location  
dimensional\_characteristic = dimensional\_location  
dimensional\_characteristic <=  
dimensional\_characteristic\_representation.dimension  
dimensional\_characteristic\_representation  
dimensional\_characteristic\_representation.representation ->  
shape\_dimension\_representation <=  
shape\_representation <=  
{representation  
representation.name = 'hvac offset centred dimensional shape'}  
representation  
representation.items[i] ->

```

representation_item =>
{representation_item.name = 'heel radius'}
measure_representation_item <=
{measure_with_unit =>
length_measure_with_unit}
measure_with_unit
[measure_with_unit.value_component]
[measure_with_unit.unit_component]

```

#### 5.1.6.16.6 end\_1\_connector

AIM element: hvac\_connector

Source: 227

Reference path: hvac\_component\_definition <=

```

product_definition
characterized_product_definition = product_definition
characterized_product_definition
characterized_definition = characterized_product_definition
characterized_definition <-
property_definition.definition
property_definition =>
product_definition_shape <-
shape_aspect.of_shape
{shape_aspect
shape_aspect.description = 'end 1'}
shape_aspect =>
hvac_connector

```

#### 5.1.6.16.7 end\_2\_connector

AIM element: hvac\_connector

Source: 227

Reference path: hvac\_component\_definition <=

```

product_definition
characterized_product_definition = product_definition
characterized_product_definition
characterized_definition = characterized_product_definition
characterized_definition <-
property_definition.definition
property_definition =>
product_definition_shape <-
shape_aspect.of_shape
{shape_aspect
shape_aspect.description = 'end 2'}
shape_aspect =>
hvac_connector

```

### 5.1.6.16.8 hvac\_offset\_centred to splitter

AIM element: PATH

Reference path: hvac\_component\_definition <=  
 product\_definition  
 characterized\_product\_definition = product\_definition  
 characterized\_product\_definition  
 characterized\_definition = characterized\_product\_definition  
 characterized\_definition <=  
 property\_definition.definition  
 property\_definition =>  
 product\_definition\_shape <=  
 shape\_aspect.of\_shape  
 shape\_aspect  
 {shape\_aspect.description = 'splitter'}

### 5.1.6.17 Hvac\_offset\_ogee\_centred

AIM element: hvac\_component\_definition

Source: 227

Rules: dependent\_instantiable\_product\_context  
 product\_context\_discipline\_type\_constraint  
 value\_for\_application\_context

Reference path: hvac\_component\_definition <=  
 product\_definition  
 {hvac\_component\_definition  
 classification\_item = hvac\_component\_definition  
 classification\_item <=  
 applied\_classification\_assignment.items[i]  
 applied\_classification\_assignment <=  
 classification\_assignment  
 classification\_assignment.assigned\_classification ->  
 [group =>  
 hvac\_fitting\_class]  
 [group  
 group.name = 'hvac offset ogee centred']}  
 {product\_definition  
 product\_definition.formation ->  
 product\_definition\_formation  
 product\_definition\_formation.of\_product ->  
 [product  
 classification\_item = product  
 classification\_item <=  
 applied\_classification\_assignment.items[i]  
 applied\_classification\_assignment <=  
 classification\_assignment  
 classification\_assignment.assigned\_classification ->  
 (group)  
 (group <=

```

group_relationship.related_group
group_relationship
group_relationship.relying_group ->
group)
group.name = 'hvac fitting']
[product
product.frame_of_reference[i] ->
product_context <=
application_context_element
application_context_element.name = 'plant item']))

```

### 5.1.6.17.1 angle

AIM element: [measure\_with\_unit.value\_component]  
[measure\_with\_unit.unit\_component]

Source: 41

Rules: subtype\_mandatory\_shape\_representation

Reference path: hvac\_component\_definition <=  
product\_definition  
characterized\_product\_definition = product\_definition  
characterized\_product\_definition  
characterized\_definition = characterized\_product\_definition  
characterized\_definition <=  
property\_definition.definition  
property\_definition =>  
product\_definition\_shape <=  
shape\_aspect.of\_shape  
[shape\_aspect <=  
shape\_aspect\_relationship.relying\_shape\_aspect]  
[shape\_aspect <=  
shape\_aspect\_relationship.related\_shape\_aspect]  
shape\_aspect\_relationship =>  
dimensional\_location  
dimensional\_characteristic = dimensional\_location  
dimensional\_characteristic <=  
dimensional\_characteristic\_representation.dimensional  
dimensional\_characteristic\_representation  
dimensional\_characteristic\_representation.representation ->  
shape\_dimension\_representation <=  
shape\_representation <=  
{representation  
representation.name = 'hvac offset ogee centred dimensional shape'}  
representation  
representation.items[i] ->  
representation\_item =>  
{representation\_item.name = 'angle'}  
measure\_representation\_item <=  
{measure\_with\_unit =>  
plane\_angle\_measure\_with\_unit}  
measure\_with\_unit

[measure\_with\_unit.value\_component]  
 [measure\_with\_unit.unit\_component]

### 5.1.6.17.2 offset

AIM element: [measure\_with\_unit.value\_component]  
 [measure\_with\_unit.unit\_component]

Source: 41

Rules: subtype\_mandatory\_shape\_representation

Reference path: hvac\_component\_definition <=  
 product\_definition  
 characterized\_product\_definition = product\_definition  
 characterized\_product\_definition  
 characterized\_definition = characterized\_product\_definition  
 characterized\_definition <=  
 property\_definition.definition  
 property\_definition =>  
 product\_definition\_shape <=  
 shape\_aspect.of\_shape  
 [shape\_aspect <=  
 shape\_aspect\_relationship.relating\_shape\_aspect]  
 [shape\_aspect <=  
 shape\_aspect\_relationship.related\_shape\_aspect]  
 shape\_aspect\_relationship =>  
 dimensional\_location  
 dimensional\_characteristic = dimensional\_location  
 dimensional\_characteristic <=  
 dimensional\_characteristic\_representation.dimension  
 dimensional\_characteristic\_representation  
 dimensional\_characteristic\_representation.representation ->  
 shape\_dimension\_representation <=  
 shape\_representation <=  
 {representation  
 representation.name = 'hvac offset ogee centred dimensional shape'}  
 representation  
 representation.items[i] ->  
 representation\_item =>  
 {representation\_item.name = 'offset'}  
 measure\_representation\_item <=  
 {measure\_with\_unit =>  
 length\_measure\_with\_unit}  
 measure\_with\_unit  
 [measure\_with\_unit.value\_component]  
 [measure\_with\_unit.unit\_component]

### 5.1.6.17.3 length

AIM element: [measure\_with\_unit.value\_component]  
 [measure\_with\_unit.unit\_component]

Source: 41

Rules: subtype\_mandatory\_shape\_representation

Reference path: hvac\_component\_definition <=  
product\_definition  
characterized\_product\_definition = product\_definition  
characterized\_product\_definition  
characterized\_definition = characterized\_product\_definition  
characterized\_definition <=  
property\_definition.definition  
property\_definition =>  
product\_definition\_shape <=  
shape\_aspect.of\_shape  
[shape\_aspect <=  
shape\_aspect\_relationship.relate\_shape\_aspect]  
[shape\_aspect <=  
shape\_aspect\_relationship.related\_shape\_aspect]  
shape\_aspect\_relationship =>  
dimensional\_location  
dimensional\_characteristic = dimensional\_location  
dimensional\_characteristic <=  
dimensional\_characteristic\_representation.dimension  
dimensional\_characteristic\_representation  
dimensional\_characteristic\_representation.representation ->  
shape\_dimension\_representation <=  
shape\_representation <=  
{representation  
representation.name = 'hvac offset ogee centred dimensional shape'}  
representation  
representation.items[i] ->  
representation\_item =>  
{representation\_item.name = 'length'}  
measure\_representation\_item <=  
{measure\_with\_unit =>  
length\_measure\_with\_unit}  
measure\_with\_unit  
[measure\_with\_unit.value\_component]  
[measure\_with\_unit.unit\_component]

#### 5.1.6.17.4 throat\_radius

AIM element: [measure\_with\_unit.value\_component]  
[measure\_with\_unit.unit\_component]

Source: 41

Rules: subtype\_mandatory\_shape\_representation

Reference path: hvac\_component\_definition <=  
product\_definition  
characterized\_product\_definition = product\_definition  
characterized\_product\_definition  
characterized\_definition = characterized\_product\_definition

```

characterized_definition <-
property_definition.definition
property_definition =>
product_definition_shape <-
shape_aspect.of_shape
[shape_aspect <-
shape_aspect_relationship.relating_shape_aspect]
[shape_aspect <-
shape_aspect_relationship.related_shape_aspect]
shape_aspect_relationship =>
dimensional_location
dimensional_characteristic = dimensional_location
dimensional_characteristic <-
dimensional_characteristic_representation.dimension
dimensional_characteristic_representation
dimensional_characteristic_representation.representation ->
shape_dimension_representation <=
shape_representation <=
{representation
representation.name = 'hvac offset ogee centred dimensional shape'}
representation
representation.items[i] ->
representation_item =>
{representation_item.name = 'throat radius'}
measure_representation_item <=
{measure_with_unit =>
length_measure_with_unit}
measure_with_unit
[measure_with_unit.value_component]
[measure_with_unit.unit_component]

```

### 5.1.6.17.5 heel\_radius

AIM element: [measure\_with\_unit.value\_component]  
[measure\_with\_unit.unit\_component]

Source: 41

Rules: subtype\_mandatory\_shape\_representation

Reference path: hvac\_component\_definition <=  
product\_definition  
characterized\_product\_definition = product\_definition  
characterized\_product\_definition  
characterized\_definition = characterized\_product\_definition  
characterized\_definition <-  
property\_definition.definition  
property\_definition =>  
product\_definition\_shape <-  
shape\_aspect.of\_shape  
[shape\_aspect <-  
shape\_aspect\_relationship.relating\_shape\_aspect]  
[shape\_aspect <-  
shape\_aspect\_relationship.related\_shape\_aspect]

```

shape_aspect_relationship =>
dimensional_location
dimensional_characteristic = dimensional_location
dimensional_characteristic <-
dimensional_characteristic_representation.dimensional_location
dimensional_characteristic_representation
dimensional_characteristic_representation.representation ->
shape_dimension_representation <=
shape_representation <=
{representation
representation.name = 'hvac offset ogee centred dimensional shape'}
representation
representation.items[i] ->
representation_item =>
{representation_item.name = 'heel radius'}
measure_representation_item <=
{measure_with_unit =>
length_measure_with_unit}
measure_with_unit
[measure_with_unit.value_component]
[measure_with_unit.unit_component]

```

#### 5.1.6.17.6 end\_1\_connector

AIM element: hvac\_connector

Source: 227

Reference path: hvac\_component\_definition <=

```

product_definition
characterized_product_definition = product_definition
characterized_product_definition
characterized_definition = characterized_product_definition
characterized_definition <-
property_definition.definition
property_definition =>
product_definition_shape <-
shape_aspect.of_shape
{shape_aspect
shape_aspect.description = 'end 1'}
shape_aspect =>
hvac_connector

```

#### 5.1.6.17.7 end\_2\_connector

AIM element: hvac\_connector

Source: 227

Reference path: hvac\_component\_definition <=

```

product_definition
characterized_product_definition = product_definition
characterized_product_definition

```

```

characterized_definition = characterized_product_definition
characterized_definition <-
property_definition.definition
property_definition =>
product_definition_shape <-
shape_aspect.of_shape
{shape_aspect
shape_aspect.description = 'end 2'}
shape_aspect =>
hvac_connector

```

### 5.1.6.18 Hvac\_takeoff

AIM element: hvac\_component\_definition

Source: 227

Rules: dependent\_instantiable\_product\_context  
product\_context\_discipline\_type\_constraint  
value\_for\_application\_context

Reference path: hvac\_component\_definition <=  
product\_definition  
{hvac\_component\_definition  
classification\_item = hvac\_component\_definition  
classification\_item <-  
applied\_classification\_assignment.items[i]  
applied\_classification\_assignment <=  
classification\_assignment  
classification\_assignment.assigned\_classification ->  
[group =>  
hvac\_fitting\_class]  
[group  
group.name = 'hvac takeoff']}  
{product\_definition  
product\_definition.formation ->  
product\_definition\_formation  
product\_definition\_formation.of\_product ->  
[product  
classification\_item = product  
classification\_item <-  
applied\_classification\_assignment.items[i]  
applied\_classification\_assignment <=  
classification\_assignment  
classification\_assignment.assigned\_classification ->  
(group)  
(group <-  
group\_relationship.related\_group  
group\_relationship  
group\_relationship.relating\_group ->  
group)  
group.name = 'hvac fitting']  
[product

```

product.frame_of_reference[i] ->
product_context <=
application_context_element
application_context_element.name = 'plant item']})

```

### 5.1.6.18.1 end\_1\_connector

AIM element: hvac\_connector

Source: 227

Reference path:

```

hvac_component_definition <=
product_definition
characterized_product_definition = product_definition
characterized_product_definition
characterized_definition = characterized_product_definition
characterized_definition <-
property_definition.definition
property_definition =>
product_definition_shape <-
shape_aspect.of_shape
{shape_aspect
shape_aspect.description = 'end 1'}
shape_aspect =>
hvac_connector

```

### 5.1.6.18.2 end\_2\_connector

AIM element: hvac\_connector

Source: 227

Reference path:

```

hvac_component_definition <=
product_definition
characterized_product_definition = product_definition
characterized_product_definition
characterized_definition = characterized_product_definition
characterized_definition <-
property_definition.definition
property_definition =>
product_definition_shape <-
shape_aspect.of_shape
{shape_aspect
shape_aspect.description = 'end 2'}
shape_aspect =>
hvac_connector

```

### 5.1.6.18.3 end\_3\_connector

AIM element: hvac\_connector

Source: 227

Reference path: hvac\_component\_definition <=  
 product\_definition  
 characterized\_product\_definition = product\_definition  
 characterized\_product\_definition  
 characterized\_definition = characterized\_product\_definition  
 characterized\_definition <=  
 property\_definition.definition  
 property\_definition =>  
 product\_definition\_shape <=  
 shape\_aspect.of\_shape  
 {shape\_aspect  
 shape\_aspect.description = 'end '}  
 shape\_aspect =>  
 hvac\_connector

#### 5.1.6.18.4 centre\_to\_end\_1\_length

AIM element: [measure\_with\_unit.value\_component]  
 [measure\_with\_unit.unit\_component]

Source: 41

Rules: subtype\_mandatory\_shape\_representation

Reference path: hvac\_component\_definition <=  
 product\_definition  
 characterized\_product\_definition = product\_definition  
 characterized\_product\_definition  
 characterized\_definition = characterized\_product\_definition  
 characterized\_definition <=  
 property\_definition.definition  
 property\_definition =>  
 product\_definition\_shape <=  
 shape\_aspect.of\_shape  
 [shape\_aspect <=  
 shape\_aspect\_relationship.relating\_shape\_aspect]  
 [shape\_aspect <=  
 shape\_aspect\_relationship.related\_shape\_aspect]  
 shape\_aspect\_relationship =>  
 dimensional\_location  
 dimensional\_characteristic = dimensional\_location  
 dimensional\_characteristic <=  
 dimensional\_characteristic\_representation.dimension  
 dimensional\_characteristic\_representation  
 dimensional\_characteristic\_representation.representation ->  
 shape\_dimension\_representation <=  
 shape\_representation <=  
 {representation  
 representation.name = 'hvac takeoff dimensional shape'}  
 representation  
 representation.items[i] ->  
 representation\_item =>  
 {representation\_item.name = 'centre to end 1 length'}  
 measure\_representation\_item <=

```

{measure_with_unit =>
length_measure_with_unit}
measure_with_unit
[measure_with_unit.value_component]
[measure_with_unit.unit_component]

```

### 5.1.6.18.5 centre\_to\_end\_2\_length

AIM element: [measure\_with\_unit.value\_component]  
[measure\_with\_unit.unit\_component]

Source: 41

Rules: subtype\_mandatory\_shape\_representation

Reference path: hvac\_component\_definition <=  
product\_definition  
characterized\_product\_definition = product\_definition  
characterized\_product\_definition  
characterized\_definition = characterized\_product\_definition  
characterized\_definition <=  
property\_definition.definition  
property\_definition =>  
product\_definition\_shape <=  
shape\_aspect.of\_shape  
[shape\_aspect <=  
shape\_aspect\_relationship.relate\_shape\_aspect]  
[shape\_aspect <=  
shape\_aspect\_relationship.related\_shape\_aspect]  
shape\_aspect\_relationship =>  
dimensional\_location  
dimensional\_characteristic = dimensional\_location  
dimensional\_characteristic <=  
dimensional\_characteristic\_representation.dimension  
dimensional\_characteristic\_representation  
dimensional\_characteristic\_representation.representation ->  
shape\_dimension\_representation <=  
shape\_representation <=  
{representation  
representation.name = 'hvac takeoff dimensional shape'}  
representation  
representation.items[i] ->  
representation\_item =>  
{representation\_item.name = 'centre to end 2 length'}  
measure\_representation\_item <=  
{measure\_with\_unit =>  
length\_measure\_with\_unit}  
measure\_with\_unit  
[measure\_with\_unit.value\_component]  
[measure\_with\_unit.unit\_component]

### 5.1.6.18.6 centre\_to\_end\_3\_length

AIM element: [measure\_with\_unit.value\_component]  
[measure\_with\_unit.unit\_component]

Source: 41

Rules: subtype\_mandatory\_shape\_representation

Reference path: hvac\_component\_definition <=  
product\_definition  
characterized\_product\_definition = product\_definition  
characterized\_product\_definition  
characterized\_definition = characterized\_product\_definition  
characterized\_definition <=  
property\_definition.definition  
property\_definition =>  
product\_definition\_shape <=  
shape\_aspect.of\_shape  
[shape\_aspect <=  
shape\_aspect\_relationship.relating\_shape\_aspect]  
[shape\_aspect <=  
shape\_aspect\_relationship.related\_shape\_aspect]  
shape\_aspect\_relationship =>  
dimensional\_location  
dimensional\_characteristic = dimensional\_location  
dimensional\_characteristic <=  
dimensional\_characteristic\_representation.dimension  
dimensional\_characteristic\_representation  
dimensional\_characteristic\_representation.representation ->  
shape\_dimension\_representation <=  
shape\_representation <=  
{representation  
representation.name = 'hvac takeoff dimensional shape'}  
representation  
representation.items[i] ->  
representation\_item =>  
{representation\_item.name = 'centre to end 3 length'}  
measure\_representation\_item <=  
{measure\_with\_unit =>  
length\_measure\_with\_unit}  
measure\_with\_unit  
[measure\_with\_unit.value\_component]  
[measure\_with\_unit.unit\_component]

#### 5.1.6.18.7 takeoff\_angle

AIM element: [measure\_with\_unit.value\_component]  
[measure\_with\_unit.unit\_component]

Source: 41

Rules: subtype\_mandatory\_shape\_representation

Reference path: hvac\_component\_definition <=  
product\_definition

```

characterized_product_definition = product_definition
characterized_product_definition
characterized_definition = characterized_product_definition
characterized_definition <-
property_definition.definition
property_definition =>
product_definition_shape <-
shape_aspect.of_shape
[shape_aspect <-
shape_aspect_relationship.relating_shape_aspect]
[shape_aspect <-
shape_aspect_relationship.related_shape_aspect]
shape_aspect_relationship =>
dimensional_location
dimensional_characteristic = dimensional_location
dimensional_characteristic <-
dimensional_characteristic_representation.dimension
dimensional_characteristic_representation
dimensional_characteristic_representation.representation ->
shape_dimension_representation <=
shape_representation <=
{representation
representation.name = 'hvac takeoff dimensional shape'}
representation
representation.items[i] ->
representation_item =>
{representation_item.name = 'takeoff angle'}
measure_representation_item <=
{measure_with_unit =>
plane_angle_measure_with_unit}
measure_with_unit
[measure_with_unit.value_component]
[measure_with_unit.unit_component]

```

### 5.1.6.19 Hvac\_transition

AIM element:	hvac_component_definition
Source:	227
Rules:	dependent_instantiable_product_context product_context_discipline_type_constraint value_for_application_context
Reference path:	hvac_component_definition <= product_definition {hvac_component_definition classification_item = hvac_component_definition classification_item <- applied_classification_assignment.items[i] applied_classification_assignment <= classification_assignment classification_assignment.assigned_classification ->  [group =>

```

hvac_fitting_class]
[group
group.name = 'hvac transition']]
{product_definition
product_definition.formation ->
product_definition_formation
product_definition_formation.of_product ->
[product
classification_item = product
classification_item <-
applied_classification_assignment.items[i]
applied_classification_assignment <=
classification_assignment
classification_assignment.assigned_classification ->
(group)
(group <-
group_relationship.related_group
group_relationship
group_relationship.relate_group ->
group)
group.name = 'hvac fitting']
[product
product.frame_of_reference[i] ->
product_context <=
application_context_element
application_context_element.name = 'plant item']]

```

#### 5.1.6.19.1 offset\_x

AIM element: [measure\_with\_unit.value\_component]  
[measure\_with\_unit.unit\_component]

Source: 41

Rules: subtype\_mandatory\_shape\_representation

Reference path: hvac\_component\_definition <=  
product\_definition  
characterized\_product\_definition = product\_definition  
characterized\_product\_definition  
characterized\_definition = characterized\_product\_definition  
characterized\_definition <-  
property\_definition.definition  
property\_definition =>  
product\_definition\_shape <-  
shape\_aspect.of\_shape  
[shape\_aspect <-  
shape\_aspect\_relationship.relate\_shape\_aspect]  
[shape\_aspect <-  
shape\_aspect\_relationship.related\_shape\_aspect]  
shape\_aspect\_relationship =>  
dimensional\_location  
dimensional\_characteristic = dimensional\_location  
dimensional\_characteristic <-

```

dimensional_characteristic_representation.dimension
dimensional_characteristic_representation
dimensional_characteristic_representation.representation ->
shape_dimension_representation <=
shape_representation <=
{representation
representation.name = 'hvac transition dimensional shape'}
representation
representation.items[i] ->
representation_item =>
{representation_item.name = 'offset x'}
measure_representation_item <=
{measure_with_unit =>
length_measure_with_unit}
measure_with_unit
[measure_with_unit.value_component]
[measure_with_unit.unit_component]

```

### 5.1.6.19.2 offset\_y

AIM element: [measure\_with\_unit.value\_component]  
[measure\_with\_unit.unit\_component]

Source: 41

Rules: subtype\_mandatory\_shape\_representation

Reference path: hvac\_component\_definition <=  
product\_definition  
characterized\_product\_definition = product\_definition  
characterized\_product\_definition  
characterized\_definition = characterized\_product\_definition  
characterized\_definition <=  
property\_definition.definition  
property\_definition =>  
product\_definition\_shape <=  
shape\_aspect.of\_shape  
[shape\_aspect <=  
shape\_aspect\_relationship.relate\_shape\_aspect]  
[shape\_aspect <=  
shape\_aspect\_relationship.related\_shape\_aspect]  
shape\_aspect\_relationship =>  
dimensional\_location  
dimensional\_characteristic = dimensional\_location  
dimensional\_characteristic <=  
dimensional\_characteristic\_representation.dimension  
dimensional\_characteristic\_representation  
dimensional\_characteristic\_representation.representation ->  
shape\_dimension\_representation <=  
shape\_representation <=  
{representation  
representation.name = 'hvac transition dimensional shape'}  
representation  
representation.items[i] ->

```

representation_item =>
{representation_item.name = 'offset y'}
measure_representation_item <=
{measure_with_unit =>
length_measure_with_unit}
measure_with_unit
[measure_with_unit.value_component]
[measure_with_unit.unit_component]

```

### 5.1.6.19.3 length

AIM element: [measure\_with\_unit.value\_component]  
[measure\_with\_unit.unit\_component]

Source: 41

Rules: subtype\_mandatory\_shape\_representation

Reference path: hvac\_component\_definition <=  
product\_definition  
characterized\_product\_definition = product\_definition  
characterized\_product\_definition  
characterized\_definition = characterized\_product\_definition  
characterized\_definition <=  
property\_definition.definition  
property\_definition =>  
product\_definition\_shape <=  
shape\_aspect.of\_shape  
[shape\_aspect <=  
shape\_aspect\_relationship.relate\_shape\_aspect]  
[shape\_aspect <=  
shape\_aspect\_relationship.related\_shape\_aspect]  
shape\_aspect\_relationship =>  
dimensional\_location  
dimensional\_characteristic = dimensional\_location  
dimensional\_characteristic <=  
dimensional\_characteristic\_representation.dimensional  
dimensional\_characteristic\_representation  
dimensional\_characteristic\_representation.representation ->  
shape\_dimension\_representation <=  
shape\_representation <=  
{representation  
representation.name = 'hvac transition dimensional shape'}  
representation  
representation.items[i] ->  
representation\_item =>  
{representation\_item.name = 'length'}  
measure\_representation\_item <=  
{measure\_with\_unit =>  
length\_measure\_with\_unit}  
measure\_with\_unit  
[measure\_with\_unit.value\_component]  
[measure\_with\_unit.unit\_component]

**5.1.6.19.4 end\_1\_connector**

AIM element: hvac\_connector

Source: 227

Reference path: hvac\_component\_definition <=  
product\_definition  
characterized\_product\_definition = product\_definition  
characterized\_product\_definition  
characterized\_definition = characterized\_product\_definition  
characterized\_definition <=  
property\_definition.definition  
property\_definition =>  
product\_definition\_shape <=  
shape\_aspect.of\_shape  
{shape\_aspect  
shape\_aspect.description = 'end 1'}  
shape\_aspect =>  
hvac\_connector

**5.1.6.19.5 end\_2\_connector**

AIM element: hvac\_connector

Source: 227

Reference path: hvac\_component\_definition <=  
product\_definition  
characterized\_product\_definition = product\_definition  
characterized\_product\_definition  
characterized\_definition = characterized\_product\_definition  
characterized\_definition <=  
property\_definition.definition  
property\_definition =>  
product\_definition\_shape <=  
shape\_aspect.of\_shape  
{shape\_aspect  
shape\_aspect.description = 'end 2'}  
shape\_aspect =>  
hvac\_connector

**5.1.6.20 Hvac\_transition\_slanted**

AIM element: hvac\_component\_definition

Source: 227

Rules: dependent\_instantiable\_product\_context  
product\_context\_discipline\_type\_constraint  
value\_for\_application\_context

Reference path: hvac\_component\_definition <=

```

product_definition
{hvac_component_definition
classification_item = hvac_component_definition
classification_item <-
applied_classification_assignment.items[i]
applied_classification_assignment <=
classification_assignment
classification_assignment.assigned_classification ->
[group =>
hvac_fitting_class]
[group
group.name = 'hvac transition slanted']]
{product_definition
product_definition.formation ->
product_definition_formation
product_definition_formation.of_product ->
[product
classification_item = product
classification_item <-
applied_classification_assignment.items[i]
applied_classification_assignment <=
classification_assignment
classification_assignment.assigned_classification ->
(group)
(group <-
group_relationship.related_group
group_relationship
group_relationship.relate_group ->
group)
group.name = 'hvac fitting']
[product
product.frame_of_reference[i] ->
product_context <=
application_context_element
application_context_element.name = 'plant item']]

```

#### 5.1.6.20.1 slant\_angle

AIM element: [measure\_with\_unit.value\_component]  
[measure\_with\_unit.unit\_component]

Source: 41

Rules: subtype\_mandatory\_shape\_representation

Reference path: hvac\_component\_definition <=  
product\_definition  
characterized\_product\_definition = product\_definition  
characterized\_product\_definition  
characterized\_definition = characterized\_product\_definition  
characterized\_definition <-  
property\_definition.definition  
property\_definition =>  
product\_definition\_shape <-

```

shape_aspect.of_shape
[shape_aspect <-
shape_aspect_relationship.relating_shape_aspect]
[shape_aspect <-
shape_aspect_relationship.related_shape_aspect]
shape_aspect_relationship =>
dimensional_location
dimensional_characteristic = dimensional_location
dimensional_characteristic <-
dimensional_characteristic_representation.dimension
dimensional_characteristic_representation
dimensional_characteristic_representation.representation ->
shape_dimension_representation <=
shape_representation <=
{representation
representation.name = 'hvac transition slanted dimensional shape'}
representation
representation.items[i] ->
representation_item =>
{representation_item.name = 'slant angle'}
measure_representation_item <=
{measure_with_unit =>
plane_angle_measure_with_unit}
measure_with_unit
[measure_with_unit.value_component]
[measure_with_unit.unit_component]

```

### 5.1.6.20.2 length

AIM element: [measure\_with\_unit.value\_component]  
[measure\_with\_unit.unit\_component]

Source: 41

Rules: subtype\_mandatory\_shape\_representation

Reference path: hvac\_component\_definition <=  
product\_definition  
characterized\_product\_definition = product\_definition  
characterized\_product\_definition  
characterized\_definition = characterized\_product\_definition  
characterized\_definition <-  
property\_definition.definition  
property\_definition =>  
product\_definition\_shape <-  
shape\_aspect.of\_shape  
[shape\_aspect <-  
shape\_aspect\_relationship.relating\_shape\_aspect]  
[shape\_aspect <-  
shape\_aspect\_relationship.related\_shape\_aspect]  
shape\_aspect\_relationship =>  
dimensional\_location  
dimensional\_characteristic = dimensional\_location  
dimensional\_characteristic <-

```

dimensional_characteristic_representation.dimension
dimensional_characteristic_representation
dimensional_characteristic_representation.representation ->
shape_dimension_representation <=
shape_representation <=
{representation
representation.name = 'hvac transition slanted dimensional shape'}
representation
representation.items[i] ->
representation_item =>
{representation_item.name = 'length'}
measure_representation_item <=
{measure_with_unit =>
length_measure_with_unit}
measure_with_unit
[measure_with_unit.value_component]
[measure_with_unit.unit_component]

```

### 5.1.6.20.3 end\_1\_connector

AIM element: hvac\_connector

Source: 227

Reference path: hvac\_component\_definition <=

```

product_definition
characterized_product_definition = product_definition
characterized_product_definition
characterized_definition = characterized_product_definition
characterized_definition <-
property_definition.definition
property_definition =>
product_definition_shape <-
shape_aspect.of_shape
{shape_aspect
shape_aspect.description = 'end 1'}
shape_aspect =>
hvac_connector

```

### 5.1.6.20.4 end\_2\_connector

AIM element: hvac\_connector

Source: 227

Reference path: hvac\_component\_definition <=

```

product_definition
characterized_product_definition = product_definition
characterized_product_definition
characterized_definition = characterized_product_definition
characterized_definition <-
property_definition.definition
property_definition =>

```

```

product_definition_shape <-
shape_aspect.of_shape
{shape_aspect
shape_aspect.description = 'end 2'}
shape_aspect =>
hvac_connector

```

### 5.1.6.21 Splitter

AIM element: shape\_aspect

Source: 41

Reference path: shape\_aspect  
{shape\_aspect.description = 'splitter'}

#### 5.1.6.21.1 splitter\_id

AIM element: shape\_aspect.name

Source: 41

#### 5.1.6.21.2 splitter\_radius

AIM element: [measure\_with\_unit.value\_component]  
[measure\_with\_unit.unit\_component]

Source: 41

Reference path: shape\_aspect  
shape\_definition = shape\_aspect  
shape\_definition  
characterized\_definition = shape\_definition  
characterized\_definition <-  
property\_definition.definition  
property\_definition  
represented\_definition = property\_definition  
represented\_definition <-  
property\_definition\_representation.definition  
property\_definition\_representation  
property\_definition\_representation.used\_representation ->  
representation  
{representation.name = 'splitter dimensional representation'}  
representation.items[i] ->  
representation\_item =>  
{representation\_item.name = 'radius'}  
measure\_representation\_item <=  
{measure\_with\_unit =>  
length\_measure\_with\_unit}  
measure\_with\_unit  
[measure\_with\_unit.value\_component]  
[measure\_with\_unit.unit\_component]

**5.1.6.21.3 splitter\_radius\_centre\_offset**

AIM element: [measure\_with\_unit.value\_component]  
[measure\_with\_unit.unit\_component]

Source: 41

Reference path: shape\_aspect  
 shape\_definition = shape\_aspect  
 shape\_definition  
 characterized\_definition = shape\_definition  
 characterized\_definition <-  
 property\_definition.definition  
 property\_definition  
 represented\_definition = property\_definition  
 represented\_definition <-  
 property\_definition\_representation.definition  
 property\_definition\_representation  
 property\_definition\_representation.used\_representation ->  
 representation  
 {representation.name = 'splitter dimensional representation'}  
 representation.items[i] ->  
 representation\_item =>  
 {representation\_item.name = 'radius centre offset'}  
 measure\_representation\_item <=  
 {measure\_with\_unit =>  
 length\_measure\_with\_unit}  
 measure\_with\_unit  
 [measure\_with\_unit.value\_component]  
 [measure\_with\_unit.unit\_component]

**5.1.6.21.4 straight\_portion\_length**

AIM element: [measure\_with\_unit.value\_component]  
[measure\_with\_unit.unit\_component]

Source: 41

Reference path: shape\_aspect  
 shape\_definition = shape\_aspect  
 shape\_definition  
 characterized\_definition = shape\_definition  
 characterized\_definition <-  
 property\_definition.definition  
 property\_definition  
 represented\_definition = property\_definition  
 represented\_definition <-  
 property\_definition\_representation.definition  
 property\_definition\_representation  
 property\_definition\_representation.used\_representation ->  
 representation  
 {representation.name = 'splitter dimensional representation'}  
 representation.items[i] ->  
 representation\_item =>

```

{representation_item.name = 'straight portion length'}
measure_representation_item <=
{measure_with_unit =>
length_measure_with_unit}
measure_with_unit
[measure_with_unit.value_component]
[measure_with_unit.unit_component]

```

## 5.1.7 HVAC\_system\_functional\_characterization UoF

### 5.1.7.1 Hvac\_plant\_item\_branch\_connection

AIM element: hvac\_plant\_item\_branch\_connection

Source: 227

Reference path: hvac\_plant\_item\_branch\_connection <=

```

shape_aspect_relationship
{shape_aspect_relationship
[shape_aspect_relationship.relating_shape_aspect ->
shape_aspect
shape_aspect.of_shape ->
product_definition_shape <=
property_definition
property_definition.definition ->
characterized_definition
characterized_definition = characterized_product_definition
characterized_product_definition
characterized_product_definition = product_definition
product_definition =>
hvac_section_segment_definition]
[shape_aspect_relationship.related_shape_aspect ->
shape_aspect =>
plant_item_connector]}}

```

#### 5.1.7.1.1 branch\_sequence\_id

AIM element: shape\_aspect\_relationship.name

Source: 41

Reference path: hvac\_plant\_item\_branch\_connection <=

```

{shape_aspect_relationship
shape_aspect_relationship.relating_shape_aspect ->
shape_aspect
shape_aspect.of_shape ->
product_definition_shape <-
[shape_aspect.of_shape
shape_aspect
shape_aspect.description = 'termination 1']
[shape_aspect.of_shape
shape_aspect
shape_aspect.description = 'termination 2']}}

```

shape\_aspect\_relationship  
 shape\_aspect\_relationship.name

### 5.1.7.2 Hvac\_plant\_item\_connection

AIM element: hvac\_plant\_item\_connection

Source: 227

Reference path: hvac\_plant\_item\_connection <=  
 shape\_aspect\_relationship  
 { shape\_aspect\_relationship  
 [shape\_aspect\_relationship.relating\_shape\_aspect ->  
 shape\_aspect =>  
 hvac\_section\_segment\_termination]  
 [shape\_aspect\_relationship.related\_shape\_aspect ->  
 shape\_aspect =>  
 plant\_item\_connector] }

### 5.1.7.3 Hvac\_plant\_item\_termination

AIM element: hvac\_section\_segment\_termination

Source: 227

Reference path: hvac\_section\_segment\_termination <=  
 shape\_aspect

### 5.1.7.4 Hvac\_section\_branch\_termination

AIM element: hvac\_section\_segment\_termination

Source: 227

Reference path: hvac\_section\_segment\_termination <=  
 shape\_aspect

#### 5.1.7.4.1 hvac\_section\_branch\_termination to hvac\_branch\_connection

AIM element: PATH

Reference path: hvac\_section\_segment\_termination <=  
 shape\_aspect <-  
 shape\_aspect\_relationship.related\_shape\_aspect  
 shape\_aspect\_relationship =>  
 hvac\_branch\_connection

### 5.1.7.5 Hvac\_section\_segment

AIM element: hvac\_section\_segment\_definition

Source: 227

Reference path: hvac\_section\_segment\_definition <=  
product\_definition  
{product\_definition  
product\_definition.frame\_of\_reference ->  
product\_definition\_context <=  
application\_context\_element  
application\_context\_element.name = 'functional definition'}

### 5.1.7.5.1 pressure\_drop

AIM element: [measure\_with\_unit.value\_component]  
[measure\_with\_unit.unit\_component]

Source: 41

Reference path: hvac\_section\_segment\_definition <=  
product\_definition  
characterized\_product\_definition = product\_definition  
characterized\_product\_definition  
characterized\_definition = characterized\_product\_definition  
characterized\_definition <-  
property\_definition.definition  
property\_definition <-  
represented\_definition = property\_definition  
represented\_definition <-  
property\_definition\_representation.definition  
property\_definition\_representation  
property\_definition\_representation.using\_representation ->  
representation  
{representation.name = 'hvac section segment characteristics'}  
(representation.items[i] ->  
{representation\_item  
(representation\_item.name = 'pressure drop')  
(representation\_item.name = 'maximum pressure drop')  
(representation\_item.name = 'minimum pressure drop'}})  
([representation.items[i] ->  
{representation\_item  
representation\_item.name = 'maximum pressure drop'}}]  
[representation.items[i] ->  
{representation\_item  
representation\_item.name = 'minimum pressure drop'}}])  
representation\_item =>  
measure\_representation\_item <=  
measure\_with\_unit  
[measure\_with\_unit.value\_component]  
[measure\_with\_unit.unit\_component]

### 5.1.7.5.2 hvac\_section\_segment to hvac\_plant\_item\_branch\_connection

AIM element: PATH

Reference path:   hvac\_section\_segment\_definition <=  
                   product\_definition  
                   characterized\_product\_definition = product\_definition  
                   characterized\_product\_definition  
                   characterized\_definition = characterized\_product\_definition  
                   characterized\_definition <=  
                   property\_definition.definition  
                   property\_definition =>  
                   product\_definition\_shape <=  
                   shape\_aspect.of\_shape  
                   shape\_aspect <=  
                   shape\_aspect\_relationship.relate\_shape\_aspect  
                   shape\_aspect\_relationship =>  
                   hvac\_plant\_item\_branch\_connection

### 5.1.7.5.3      **hvac\_section\_segment to hvac\_section\_segment\_insulation**

AIM element:      PATH

Reference path:   hvac\_section\_segment\_definition <=  
                   product\_definition <=  
                   product\_definition\_relationship.relate\_product\_definition  
                   product\_definition\_relationship  
                   {product\_definition\_relationship  
                   product\_definition\_relationship.name = 'hvac segment insulation'}

### 5.1.7.5.4      **hvac\_section\_segment to stream\_design\_case**

AIM element:      PATH

Reference path:   hvac\_section\_segment\_definition <=  
                   product\_definition  
                   characterized\_product\_definition = product\_definition  
                   characterized\_product\_definition  
                   characterized\_definition = characterized\_product\_definition  
                   characterized\_definition <=  
                   property\_definition.definition  
                   property\_definition =>  
                   stream\_design\_case

### 5.1.7.6      **Hvac\_section\_segment\_insulation**

AIM element:      product\_definition\_relationship

Source:            41

Reference path:   {product\_definition\_relationship  
                   [product\_definition\_relationship.name = 'hvac segment insulation']  
                   [product\_definition\_relationship.relate\_product\_definition ->  
                   product\_definition =>  
                   hvac\_section\_segment\_definition]}

**5.1.7.6.1 insulation\_thickness**

AIM element: [measure\_with\_unit.value\_component]  
[measure\_with\_unit.unit\_component]

Source: 41

Reference path: product\_definition\_relationship  
characterized\_product\_definition = product\_definition\_relationship  
characterized\_product\_definition  
characterized\_definition = characterized\_product\_definition  
characterized\_definition <-  
property\_definition.definition  
{property\_definition =>  
product\_definition\_shape}  
property\_definition  
represented\_definition = property\_definition  
represented\_definition <-  
property\_definition\_representation.definition  
{property\_definition\_representation =>  
shape\_definition\_representation}  
property\_definition\_representation  
property\_definition\_representation.used\_representation ->  
{representation  
representation.name = 'hvac segment insulation characteristics'}  
representation  
(representation.items[i] ->  
{representation\_item  
(representation\_item.name = 'thickness')  
(representation\_item.name = 'maximum thickness')  
(representation\_item.name = 'minimum thickness'}})  
([representation.items[i] ->  
{representation\_item  
representation\_item.name = 'maximum thickness'}}  
[representation.items[i] ->  
{representation\_item  
representation\_item.name = 'minimum thickness'}}]  
representation\_item =>  
measure\_representation\_item <=  
{measure\_with\_unit =>  
length\_measure\_with\_unit}  
measure\_with\_unit  
[measure\_with\_unit.value\_component]  
[measure\_with\_unit.unit\_component]

**5.1.7.6.2 insulation\_type**

AIM element: product.name

Source: 41

Reference path: product\_definition\_relationship  
product\_definition\_relationship.related\_product\_definition ->  
product\_definition

```

product_definition.formation ->
product_definition_formation
product_definition_formation.of_product ->
product
product.name

```

### 5.1.7.6.3 insulation\_description

AIM element: product\_definition\_relationship.description

Source: 41

### 5.1.7.6.4 insulation\_specification

AIM element: document

Source: 41

Reference path: product\_definition\_relationship  
document\_item = product\_definition\_relationship  
document\_item <-  
applied\_document\_reference.items[i]  
applied\_document\_reference <=  
document\_reference  
document\_reference.assigned\_document ->  
{document  
document.kind ->  
document\_type  
document\_type.product\_data\_type = 'hvac insulation specification'}  
document

### 5.1.7.7 Hvac\_section\_segment\_termination

AIM element: hvac\_section\_segment\_termination

Source: 227

Reference path: hvac\_section\_segment\_termination <=  
shape\_aspect

### 5.1.7.7.1 flow\_direction

AIM element: descriptive\_representation\_item.description

Source: 45

Reference path: hvac\_section\_segment\_definition <=  
shape\_aspect  
shape\_definition = shape\_aspect  
shape\_definition  
characterized\_definition = shape\_definition  
characterized\_definition <-

```

property_definition.definition
property_definition
represented_definition = property_definition
represented_definition <-
property_definition_representation.definition
property_definition_representation
property_definition_representation.used_representation ->
representation
representation.items[i] ->
{representation_item
representation_item.name = 'flow direction'}
representation_item =>
descriptive_representation_item
descriptive_representation_item.description
{(descriptive_representation_item.description = 'both')
(descriptive_representation_item.description = 'in')
(descriptive_representation_item.description = 'out')
(descriptive_representation_item.description = 'not specified')}]

```

### 5.1.7.7.2 start\_location

AIM element: (point)  
(shape\_aspect)

Source: 41, 42

Reference path: hvac\_section\_segment\_termination <=  
(shape\_aspect  
shape\_definition = shape\_aspect  
shape\_definition  
characterized\_definition = shape\_definition  
characterized\_definition <-  
property\_definition.definition  
property\_definition  
represented\_definition = property\_definition  
represented\_definition <-  
property\_definition\_representation.definition  
property\_definition\_representation  
property\_definition\_representation.used\_representation ->  
representation  
representation.items[i] ->  
{representation\_item  
representation\_item.name = 'section start point'}  
representation\_item =>  
geometric\_representation\_item =>  
point)  
(shape\_aspect <-  
shape\_aspect\_relationship.relate\_shape\_aspect  
shape\_aspect\_relationship  
shape\_aspect\_relationship.related\_shape\_aspect ->  
{shape\_aspect  
shape\_aspect.name = 'section start location'}  
shape\_aspect)

### 5.1.7.7.3 end\_location

AIM element: (point)  
(shape\_aspect)

Source: 41, 42

Reference path: hvac\_section\_segment\_termination <=  
(shape\_aspect  
shape\_definition = shape\_aspect  
shape\_definition  
characterized\_definition = shape\_definition  
characterized\_definition <=  
property\_definition.definition  
property\_definition  
represented\_definition = property\_definition  
represented\_definition <=  
property\_definition\_representation.definition  
property\_definition\_representation  
property\_definition\_representation.used\_representation ->  
representation  
representation.items[i] ->  
{representation\_item  
representation\_item.name = 'section end point'}  
representation\_item =>  
geometric\_representation\_item =>  
point)  
(shape\_aspect <=  
shape\_aspect\_relationship.relate\_shape\_aspect  
shape\_aspect\_relationship  
shape\_aspect\_relationship.related\_shape\_aspect ->  
{shape\_aspect  
shape\_aspect.name = 'section end location'}  
shape\_aspect)

### 5.1.7.8 Hvac\_section\_termination

AIM element: hvac\_section\_segment\_termination

Source: 227

Reference path: hvac\_section\_segment\_termination <=  
shape\_aspect  
{[shape\_aspect  
shape\_aspect.name = 'hvac section termination']  
[shape\_aspect  
shape\_aspect.of\_shape ->  
product\_definition\_shape <=  
property\_definition  
property\_definition.definition ->  
characterized\_definition  
characterized\_definition = characterized\_product\_definition  
characterized\_product\_definition  
characterized\_product\_definition = product\_definition\_relationship

```

product_definition_relationship
[product_definition_relationship.related_product_definition ->
{product_definition =>
hvac_section_segment_definition}
product_definition
product_definition.frame_of_reference ->
product_definition_context <=
application_context_element
application_context_element.name = 'functional definition']
[product_definition_relationship.representing_product_definition ->
{product_definition =>
hvac_system_section_definition}
product_definition
product_definition.frame_of_reference ->
product_definition_context <=
application_context_element
application_context_element.name = 'functional definition']]

```

#### 5.1.7.8.1 location

AIM element: cartesian\_point

Source: 42

Reference path: hvac\_section\_segment\_termination <=

```

shape_aspect
represented_definition = shape_aspect
represented_definition <-
property_definition_representation.definition
property_definition_representation
property_definition_representation.used_representation ->
{representation
representation.name = 'hvac section segment termination position'}
representation
representation.items[i] ->
representation_item =>
geometric_representation_item =>
point =>
cartesian_point

```

#### 5.1.7.8.2 start\_or\_end

AIM element: descriptive\_representation\_item.description

Source: 45

Reference path: hvac\_section\_segment\_termination <=

```

shape_aspect
represented_definition = shape_aspect
represented_definition <-
property_definition_representation.definition
property_definition_representation
property_definition_representation.used_representation ->

```

```

{representation
representation.name = 'hvac section segment termination position'}
representation
representation.items[i] ->
{representation_item
representation_item.name = 'start or end'}
representation_item =>
descriptive_representation_item
descriptive_representation_item.description
{(descriptive_representation_item.description = 'start')
(descriptive_representation_item.description = 'end')}

```

### 5.1.7.8.3 hvac\_section\_segement\_termination to hvac\_system\_section

AIM element: PATH

Reference path: hvac\_section\_segment\_termination <=  
 shape\_aspect  
 shape\_aspect.of\_shape ->  
 product\_definition\_shape <=  
 property\_definition  
 property\_definition.definition ->  
 characterized\_definition  
 characterized\_definition = characterized\_product\_definition  
 characterized\_product\_definition  
 characterized\_product\_definition = product\_definition\_relationship  
 product\_definition\_relationship  
 product\_definition\_relationship.relying\_product\_definition ->  
 {product\_definition  
 product\_definition.frame\_of\_reference ->  
 product\_definition\_context <=  
 application\_context\_element  
 application\_context\_element.name = 'functional definition'}  
 product\_definition =>  
 hvac\_system\_section\_definition

### 5.1.7.9 Hvac\_section\_to\_section\_connection

AIM element: hvac\_termination\_connection

Source: 227

Reference path: hvac\_termination\_connection <=  
 shape\_aspect\_relationship

#### 5.1.7.9.1 section\_to\_section\_connection\_id

AIM element: shape\_aspect\_relationship.name

Source: 41

Reference path: hvac\_termination\_connection <=

shape\_aspect\_relationship  
shape\_aspect\_relationship.name

#### **5.1.7.9.2 hvac\_section\_to\_section\_connection to hvac\_section\_to\_section\_termination**

AIM element: PATH

Reference path: hvac\_termination\_connection <=  
shape\_aspect\_relationship  
[shape\_aspect\_relationship.relate\_shape\_aspect ->  
shape\_aspect =>  
hvac\_termination\_connection]  
[shape\_aspect\_relationship.related\_shape\_aspect ->  
shape\_aspect =>  
hvac\_termination\_connection]

#### **5.1.7.10 Hvac\_section\_to\_section\_termination**

AIM element: hvac\_section\_segment\_termination

Source: 227

Reference path: hvac\_section\_segment\_termination <=  
shape\_aspect

#### **5.1.7.11 Hvac\_specification**

AIM element: document

Source: 41

Reference path: {document  
document.kind ->  
document\_type  
document\_type.product\_data\_type = 'hvac specification'}

##### **5.1.7.11.1 hvac\_specification\_id**

AIM element: document.id

Source: 41

##### **5.1.7.11.2 name**

AIM element: document.name

Source: 41

**5.1.7.11.3 owner**

AIM element: (organization.name)  
([person.first\_name]  
[person.last\_name])

Source: 41

Reference path: document  
(plant\_spatial\_configuration\_organization\_item = document  
plant\_spatial\_configuration\_organization\_item <-  
plant\_spatial\_configuration\_organization\_assignment.items[i]  
plant\_spatial\_configuration\_organization\_assignment <=  
{organization\_assignment  
organization\_assignment.role ->  
organization\_role  
organization\_role.name = 'owner'}  
organization\_assignment  
organization\_assignment.assigned\_organization ->  
organization  
organization.name)  
(plant\_spatial\_configuration\_person\_item = document  
plant\_spatial\_configuration\_person\_item <-  
plant\_spatial\_configuration\_person\_assignment.items[i]  
plant\_spatial\_configuration\_person\_assignment <=  
{person\_assignment  
person\_assignment.role ->  
person\_role  
person\_role.name = 'owner'}  
person\_assignment  
person\_assignment.assigned\_person ->  
person  
[person.first\_name]  
[person.last\_name])

**5.1.7.11.4 service\_description**

AIM element: document\_usage\_constraint

Source: 41

Reference path: document <-  
document\_usage\_constraint.source  
document\_usage\_constraint  
{document\_usage\_constraint  
document\_usage\_constraint.subject\_element = 'service description'}

**5.1.7.11.5 hvac\_specification to hvac\_section\_segment**

AIM element: PATH

Reference path: document <-  
document\_reference.assigned\_document

```

document_reference =>
applied_document_reference
applied_document_reference.items[i] ->
document_item
document_item = plant_line_segment_definition
hvac_section_segment_definition

```

### 5.1.7.12 Hvac\_system\_section

AIM element: hvac\_system\_section\_definition

Source: 227

Reference path: hvac\_system\_section\_definition <=  
product\_definition  
{product\_definition  
product\_definition.frame\_of\_reference ->  
product\_definition\_context <=  
application\_context\_element  
application\_context\_element.name = 'functional definition'}

#### 5.1.7.12.1 hvac\_section\_id

AIM element: product\_definition.id

Source: 41

Reference path: hvac\_system\_section\_definition <=  
product\_definition  
product\_definition.id

#### 5.1.7.12.2 hvac\_system\_section to hvac\_section\_segment

AIM element: PATH

Reference path: hvac\_system\_section\_definition <=  
product\_definition <-  
product\_definition\_relationship.relate\_definition  
product\_definition\_relationship  
product\_definition\_relationship.related\_definition ->  
product\_definition =>  
hvac\_section\_segment\_definition

## 5.1.8 Hybrid\_shape\_representation UoF

### 5.1.8.1 B\_rep\_element

AIM element: manifold\_solid\_brep

Source: 42

**5.1.8.2 Conic**

AIM element: conic

Source: 42

**5.1.8.3 Curve**

AIM element: curve

Source: 42

**5.1.8.4 Free\_form\_curve**

AIM element: b\_spline\_curve

Source: 42

**5.1.8.5 Line**

AIM element: line

Source: 42

**5.1.8.6 Point**

AIM element: point

Source: 42

**5.1.8.7 Polygon**

AIM element: polyline

Source: 42

**5.1.8.8 Surface**

AIM element: surface

Source: 42

**5.1.8.9 Vector**

AIM element: vector

Source: 42

**5.1.8.10 Wire\_and\_surface\_element**

AIM element:       geometric\_representation\_item

Source:             42

**5.1.9 Piping\_component\_characterization UoF****5.1.9.1 Base\_elbow\_support**

AIM element:       piping\_support\_definition

Source:             227

Rules:             dependent\_instantiable\_product\_context  
                      product\_context\_discipline\_type\_constraint  
                      value\_for\_application\_context

Reference path:    piping\_support\_definition <=  
                      product\_definition  
                      {piping\_support\_definition  
                       classification\_item = piping\_support\_definition  
                       classification\_item <=  
                       applied\_classification\_assignment.items[i]  
                       applied\_classification\_assignment <=  
                       classification\_assignment  
                       classification\_assignment.assigned\_classification ->  
                       [group =>  
                       piping\_support\_fitting\_-class]  
                       [group  
                       (group.name = 'base elbow support')  
                       (group.name = 'eccentric base elbow support')]]}  
                      {product\_definition  
                       product\_definition.formation ->  
                       product\_definition\_formation  
                       product\_definition\_formation.of\_product ->  
                       [product  
                       classification\_item = product  
                       classification\_item <=  
                       applied\_classification\_assignment.items[i]  
                       applied\_classification\_assignment <=  
                       classification\_assignment  
                       classification\_assignment.assigned\_classification ->  
                       (group)  
                       (group <=  
                       group\_relationship.related\_group  
                       group\_relationship  
                       group\_relationship.relate\_group ->  
                       group)  
                       group.name = 'piping support']  
                       [product  
                       product.frame\_of\_reference[i] ->  
                       product\_context <=

```

application_context_element
application_context_element.name = 'plant item']})

```

### 5.1.9.1.1 length

AIM element: [measure\_with\_unit.value\_component]  
[measure\_with\_unit.unit\_component]

Source: 41

Rules: subtype\_mandatory\_shape\_representation

Reference path: piping\_support\_definition <=  
product\_definition  
characterized\_product\_definition = product\_definition  
characterized\_product\_definition  
characterized\_definition = characterized\_product\_definition  
characterized\_definition <=  
property\_definition.definition  
property\_definition =>  
product\_definition\_shape <=  
shape\_aspect.of\_shape  
[shape\_aspect <=  
shape\_aspect\_relationship.relating\_shape\_aspect]  
[shape\_aspect <=  
shape\_aspect\_relationship.related\_shape\_aspect]  
shape\_aspect\_relationship =>  
dimensional\_location  
dimensional\_characteristic = dimensional\_location  
dimensional\_characteristic <=  
dimensional\_characteristic\_representation.dimension  
dimensional\_characteristic\_representation  
dimensional\_characteristic\_representation.representation ->  
shape\_dimension\_representation <=  
shape\_representation <=  
{representation  
representation.name = 'base elbow support dimensional shape'}  
representation  
representation.items[i] ->  
representation\_item =>  
{representation\_item.name = 'length'}  
measure\_representation\_item <=  
{measure\_with\_unit =>  
length\_measure\_with\_unit}  
measure\_with\_unit  
[measure\_with\_unit.value\_component]  
[measure\_with\_unit.unit\_component]

### 5.1.9.1.2 adjustability

AIM element: group.description

Source: 41

Reference path: `piping_support_definition`  
`classification_item = piping_support_definition`  
`classification_item <-`  
`applied_classification_assignment.items[i]`  
`applied_classification_assignment <=`  
`classification_assignment`  
`classification_assignment.assigned_classification ->`  
`group`  
`{group =>`  
`piping_support_fitting_class}`  
`group.description`  
`{(group.description = 'adjustable')}`  
`(group.description = 'non-adjustable')}`

### 5.1.9.2 Base\_line\_support

AIM element: `piping_support_definition`

Source: 227

Rules: `dependent_instantiable_product_context`  
`product_context_discipline_type_constraint`  
`value_for_application_context`

Reference path: `piping_support_definition <=`  
`product_definition`  
`{piping_support_definition`  
`classification_item = piping_support_definition`  
`classification_item <-`  
`applied_classification_assignment.items[i]`  
`applied_classification_assignment <=`  
`classification_assignment`  
`classification_assignment.assigned_classification ->`  
`[group =>`  
`piping_support_fitting_class]`  
`[group`  
`group.name = 'base line support']`  
`{product_definition`  
`product_definition.formation ->`  
`product_definition_formation`  
`product_definition_formation.of_product ->`  
`[product`  
`classification_item = product`  
`classification_item <-`  
`applied_classification_assignment.items[i]`  
`applied_classification_assignment <=`  
`classification_assignment`  
`classification_assignment.assigned_classification ->`  
`(group)`  
`(group <-`  
`group_relationship.related_group`  
`group_relationship`

```

group_relationship.relatng_group ->
group)
group.name = 'piping support']
[product
product.frame_of_reference[i] ->
product_context <=
application_context_element
application_context_element.name = 'plant item']})

```

### 5.1.9.2.1 length

AIM element: [measure\_with\_unit.value\_component]  
[measure\_with\_unit.unit\_component]

Source: 41

Rules: subtype\_mandatory\_shape\_representation

Reference path: piping\_support\_definition <=  
product\_definition  
characterized\_product\_definition = product\_definition  
characterized\_product\_definition  
characterized\_definition = characterized\_product\_definition  
characterized\_definition <=  
property\_definition.definition  
property\_definition =>  
product\_definition\_shape <=  
shape\_aspect.of\_shape  
[shape\_aspect <=  
shape\_aspect\_relationship.relatng\_shape\_aspect]  
[shape\_aspect <=  
shape\_aspect\_relationship.related\_shape\_aspect]  
shape\_aspect\_relationship =>  
dimensional\_location  
dimensional\_characteristic = dimensional\_location  
dimensional\_characteristic <=  
dimensional\_characteristic\_representation.dimension  
dimensional\_characteristic\_representation  
dimensional\_characteristic\_representation.representation ->  
shape\_dimension\_representation <=  
shape\_representation <=  
{representation  
representation.name = 'base line support dimensional shape'}  
representation  
representation.items[i] ->  
representation\_item =>  
{representation\_item.name = 'length'}  
measure\_representation\_item <=  
{measure\_with\_unit =>  
length\_measure\_with\_unit}  
measure\_with\_unit  
[measure\_with\_unit.value\_component]  
[measure\_with\_unit.unit\_component]

**5.1.9.2.2 spring**

AIM element: group.description

Source: 41

Reference path: piping\_support\_definition  
classification\_item = piping\_support\_definition  
classification\_item <-  
applied\_classification\_assignment.items[i]  
applied\_classification\_assignment <=  
classification\_assignment  
classification\_assignment.assigned\_classification ->  
group  
{[group =>  
piping\_support\_fitting\_class]  
[group  
group.name = 'base line support']}  
group.description  
{(group.description = 'with spring')  
(group.description = 'without spring')}

**5.1.9.3 Blank**

#1: The attributes are for the individual piping component.

#2: The attributes are for the definition of a family of piping components.

AIM element: #1: (piping\_component\_definition)  
#2: (piping\_component\_class)

Source: 227

Rules: dependent\_instantiable\_product\_context  
product\_context\_discipline\_type\_constraint  
value\_for\_application\_context

Reference path: #1: (piping\_component\_definition <=  
product\_definition  
{product\_definition  
product\_definition.formation ->  
product\_definition\_formation  
product\_definition\_formation.of\_product ->  
[product  
classification\_item = product  
classification\_item <-  
applied\_classification\_assignment.items[i]  
applied\_classification\_assignment <=  
classification\_assignment  
classification\_assignment.assigned\_classification ->  
(group)  
(group <-  
group\_relationship.related\_group  
group\_relationship

```

group_relationship.relatng_group ->
group)
group.name= 'blank']
[product
product.frame_of_reference[i] ->
product_context<=
application_context_element
application_context_element.name = 'plant item']})

```

```

#2: (piping_component_class <=
[characterized_object]
[group])
227

```

### 5.1.9.3.1 outside\_diameter

#1: The attributes are for the individual piping component.

#2: The attributes are for the definition of a family of piping components.

AIM element: [measure\_with\_unit.value\_component]  
[measure\_with\_unit.unit\_component]

Source: 41

Rules: subtype\_exclusive\_characterized\_object  
subtype\_mandatory\_shape\_representation

Reference path: #1: (piping\_component\_definition <=

```

product_definition
characterized_product_definition = product_definition
characterized_product_definition
characterized_definition = characterized_product_definition
characterized_definition <-
property_definition.definition
property_definition =>
product_definition_shape <-
shape_aspect.of_shape
shape_aspect <-
dimensional_size.applies_to
dimensional_size
dimensional_characteristic = dimensional_size
dimensional_characteristic <-
dimensional_characteristic_representation.dimension
dimensional_characteristic_representation
dimensional_characteristic_representation.representation ->
shape_dimension_representation <=
shape_representation <=
{representation
representation.name = 'blank fitting dimensional shape'}
representation
representation.items[i] ->
{representation_item

```

```

representation_item.name = 'outside diameter'})
#2: (piping_component_class <=
characterized_object
characterized_definition = characterized_object
characterized_definition <-
property_definition.definition
property_definition
represented_definition = property_definition
represented_definition <-
property_definition_representation.definition
property_definition_representation
property_definition_representation.used_representation ->
{representation
representation.name = 'blank fitting class dimensions'}
representation
(representation.items[i] ->
{representation_item
(representation_item.name = 'maximum outside diameter')
(representation_item.name = 'minimum outside diameter')}})
([representation.items[i] ->
{representation_item
representation_item.name = 'maximum outside diameter'}}]
[representation.items[i] ->
{representation_item
representation_item.name = 'minimum outside diameter'}}]))
representation_item =>
measure_representation_item <=
{measure_with_unit =>
length_measure_with_unit}
measure_with_unit
[measure_with_unit.value_component]
[measure_with_unit.unit_component]

```

### 5.1.9.3.2 thickness

#1: The attributes are for the individual piping component.

#2: The attributes are for the definition of a family of piping components.

AIM element: [measure\_with\_unit.value\_component]  
[measure\_with\_unit.unit\_component]

Source: 41

Rules: subtype\_exclusive\_characterized\_object  
subtype\_mandatory\_shape\_representation

Reference path: #1: (piping\_component\_definition <=
product\_definition
characterized\_product\_definition = product\_definition
characterized\_product\_definition
characterized\_definition = characterized\_product\_definition
characterized\_definition <-
property\_definition.definition

```

property_definition =>
product_definition_shape <-
shape_aspect.of_shape
[shape_aspect <-
shape_aspect_relationship.relating_shape_aspect]
[shape_aspect <-
shape_aspect_relationship.related_shape_aspect]
shape_aspect_relationship =>
dimensional_location
dimensional_characteristic = dimensional_location
dimensional_characteristic <-
dimensional_characteristic_representation.dimension
dimensional_characteristic_representation
dimensional_characteristic_representation.representation ->
shape_dimension_representation <=
shape_representation <=
{representation
representation.name = 'blank fitting dimensional shape'}
representation
representation.items[i] ->
{representation_item
representation_item.name = 'thickness'})
#2: (piping_component_class <=
characterized_object
characterized_definition = characterized_object
characterized_definition <-
property_definition.definition
property_definition
represented_definition = property_definition
represented_definition <-
property_definition_representation.definition
property_definition_representation
property_definition_representation.used_representation ->
{representation
representation.name = 'blank fitting class dimensions'}
representation
(representation.items[i] ->
{representation_item
(representation_item.name = 'maximum thickness')
(representation_item.name = 'minimum thickness'))}
([representation.items[i] ->
{representation_item
representation_item.name = 'maximum thickness'}]
[representation.items[i] ->
{representation_item
representation_item.name = 'minimum thickness'}}])
representation_item =>
measure_representation_item <=
{measure_with_unit =>
length_measure_with_unit}
measure_with_unit
[measure_with_unit.value_component]
[measure_with_unit.unit_component]

```

### 5.1.9.4 Blind\_flange

AIM element:        piping\_component\_definition

Source:             227

Rules:              dependent\_instantiable\_product\_context  
                       product\_context\_discipline\_type\_constraint  
                       value\_for\_application\_context

Reference path:    piping\_component\_definition <=  
                       product\_definition  
                       {piping\_component\_definition  
                       classification\_item = piping\_component\_definition  
                       classification\_item <=  
                       applied\_classification\_assignment.items[i]  
                       applied\_classification\_assignment <=  
                       classification\_assignment  
                       classification\_assignment.assigned\_classification ->  
                       [group =>  
                       flange\_fitting\_class]  
                       [group  
                       group.name = 'blind flange']}  
                       {product\_definition  
                       product\_definition.formation ->  
                       product\_definition\_formation  
                       product\_definition\_formation.of\_product ->  
                       [product  
                       classification\_item = product  
                       classification\_item <=  
                       applied\_classification\_assignment.items[i]  
                       applied\_classification\_assignment <=  
                       classification\_assignment  
                       classification\_assignment.assigned\_classification ->  
                       (group)  
                       (group <=  
                       group\_relationship.related\_group  
                       group\_relationship  
                       group\_relationship.relate\_group ->  
                       group)  
                       group.name= 'flange']  
                       [product  
                       product.frame\_of\_reference[i] ->  
                       product\_context<=  
                       application\_context\_element  
                       application\_context\_element.name = 'plant item']})

### 5.1.9.5 Boss

#1: The attributes are for the individual piping component.

#2: The attributes are for the definition of a family of piping components.

AIM element: #1: (piping\_component\_definition)  
 #2: (piping\_component\_class)

Source: 227

Rules: dependent\_instantiable\_product\_context  
 product\_context\_discipline\_type\_constraint  
 value\_for\_application\_context

Reference path: #1: (piping\_component\_definition <=  
 {product\_definition  
 product\_definition.formation ->  
 product\_definition\_formation  
 product\_definition\_formation.of\_product ->  
 [product  
 classification\_item = product  
 classification\_item <-  
 applied\_classification\_assignment.items[i]  
 applied\_classification\_assignment <=  
 {classification\_assignment  
 classification\_assignment.role ->  
 group\_role  
 group\_role.name = 'plant item type'}  
 classification\_assignment  
 classification\_assignment.assigned\_classification ->  
 {group  
 group.name = 'boss'}  
 group <-  
 group\_relationship.related\_group  
 group\_relationship  
 group\_relationship.relying\_group ->  
 group  
 group.name = 'olet'}}]  
 [product  
 product.frame\_of\_reference[i] ->  
 product\_context<=  
 application\_context\_element  
 application\_context\_element.name = 'plant item']}  
 product\_definition)  
 #2: (piping\_component\_class <=  
 [characterized\_object]  
 [group])  
 {[group  
 group.name = 'boss']  
 [group <-  
 group\_relationship.related\_group  
 group\_relationship  
 group\_relationship.relying\_group ->  
 group  
 group.name = 'olet']]}

**5.1.9.5.1 outside\_diameter**

AIM element: [measure\_with\_unit.value\_component]  
[measure\_with\_unit.unit\_component]

Source: 41

Rules

Reference path: piping\_component\_definition <=  
product\_definition  
characterized\_product\_definition = product\_definition  
characterized\_product\_definition  
characterized\_definition = characterized\_product\_definition  
characterized\_definition <=  
property\_definition.definition  
property\_definition =>  
product\_definition\_shape <=  
shape\_aspect.of\_shape  
shape\_aspect <=  
dimensional\_size.applies\_to  
dimensional\_size  
dimensional\_characteristic = dimensional\_size  
dimensional\_characteristic <=  
dimensional\_characteristic\_representation.dimension  
dimensional\_characteristic\_representation  
dimensional\_characteristic\_representation.representation ->  
shape\_dimension\_representation <=  
shape\_representation <=  
{representation  
representation.name = 'olet fitting dimensional shape'}  
representation  
representation.items[i] ->  
{representation\_item  
representation\_item.name = 'boss outside diameter'}

**5.1.9.6 Bushing**

#1: The attributes are for the individual piping component.

#2: The attributes are for the definition of a family of piping components.

AIM element: #1: (piping\_component\_definition)  
#2: (piping\_component\_class)

Source: 227

Rules: dependent\_instantiable\_product\_context  
product\_context\_discipline\_type\_constraint  
value\_for\_application\_context

Reference path: #1: (piping\_component\_definition <=  
product\_definition  
{product\_definition

```

product_definition.formation ->
product_definition_formation
product_definition_formation.of_product ->
[product
classification_item = product
classification_item <-
applied_classification_assignment.items[i]
applied_classification_assignment <=
classification_assignment
classification_assignment.assigned_classification ->
(group)
(group <-
group_relationship.related_group
group_relationship
group_relationship.relatng_group ->
group)
group.name = 'bushing']
[product
product.frame_of_reference[i] ->
product_context<=
application_context_element
application_context_element.name = 'plant item']]#2: (piping_component_class <=
[characterized_object]
[group])
227

```

#### 5.1.9.6.1 end\_1\_connector

AIM element: plant\_item\_connector

Source: 227

Reference path:

```

piping_component_definition <=
product_definition
characterized_product_definition = product_definition
characterized_product_definition
characterized_definition = characterized_product_definition
characterized_definition <-
property_definition.definition
property_definition =>
product_definition_shape <-
shape_aspect.of_shape
{shape_aspect
shape_aspect.description = 'end 1'}
shape_aspect =>
plant_item_connector

```

#### 5.1.9.6.2 end\_2\_connector

AIM element: plant\_item\_connector

Source: 227

Reference path:     piping\_component\_definition <=  
                           product\_definition  
                           characterized\_product\_definition = product\_definition  
                           characterized\_product\_definition  
                           characterized\_definition = characterized\_product\_definition  
                           characterized\_definition <=  
                           property\_definition.definition  
                           property\_definition =>  
                           product\_definition\_shape <=  
                           shape\_aspect.of\_shape  
                           { shape\_aspect  
                           shape\_aspect.description = 'end 2' }  
                           shape\_aspect =>  
                           plant\_item\_connector

### 5.1.9.6.3     end\_to\_end\_length

#1: The attributes are for the individual piping component.

#2: The attributes are for the definition of a family of piping components.

AIM element:       [measure\_with\_unit.value\_component]  
                       [measure\_with\_unit.unit\_component]

Source:            41

Rules:             subtype\_exclusive\_characterized\_object  
                       subtype\_mandatory\_shape\_representation

Reference path:    #1: (piping\_component\_definition <=  
                           product\_definition  
                           characterized\_product\_definition = product\_definition  
                           characterized\_product\_definition  
                           characterized\_definition = characterized\_product\_definition  
                           characterized\_definition <=  
                           property\_definition.definition  
                           property\_definition =>  
                           product\_definition\_shape <=  
                           shape\_aspect.of\_shape  
                           [ { [shape\_aspect =>  
                           plant\_item\_connector]  
                           [shape\_aspect  
                           shape\_aspect.description = 'end 1'] } }  
                           shape\_aspect <=  
                           shape\_aspect\_relationship.relying\_shape\_aspect]  
                           [ { [shape\_aspect =>  
                           plant\_item\_connector]  
                           [shape\_aspect  
                           shape\_aspect.description = 'end 2'] } }  
                           shape\_aspect <=  
                           shape\_aspect\_relationship.related\_shape\_aspect]  
                           shape\_aspect\_relationship =>  
                           dimensional\_location  
                           dimensional\_characteristic = dimensional\_location

```

dimensional_characteristic <-
dimensional_characteristic_representation.dimension
dimensional_characteristic_representation
dimensional_characteristic_representation.representation ->
shape_dimension_representation <=
shape_representation <=
{representation
representation.name = 'bushing fitting dimensional shape'}
representation
representation.items[i] ->
{representation_item
representation_item.name = 'end to end length'}}
#2: (piping_component_class <=
characterized_object
characterized_definition = characterized_object
characterized_definition <-
property_definition.definition
property_definition
represented_definition = property_definition
represented_definition <-
property_definition_representation.definition
property_definition_representation
property_definition_representation.used_representation ->
{representation
representation.name = 'bushing fitting class dimensions'}
representation
(representation.items[i] ->
{representation_item
(representation_item.name = 'maximum end to end length')
(representation_item.name = 'minimum end to end length'}})
([representation.items[i] ->
{representation_item
representation_item.name = 'maximum end to end length'}]
[representation.items[i] ->
{representation_item
representation_item.name = 'minimum end to end length'}}])
representation_item =>
measure_representation_item <=
{measure_with_unit =>
length_measure_with_unit}
measure_with_unit
[measure_with_unit.value_component]
[measure_with_unit.unit_component]

```

### 5.1.9.7 Cap

#1: The attributes are for the individual piping component.

#2: The attributes are for the definition of a family of piping components.

AIM element:       #1: (piping\_component\_definition)  
                       #2: (piping\_component\_class)

Source: 227

Rules: dependent\_instantiable\_product\_context  
product\_context\_discipline\_type\_constraint  
value\_for\_application\_context

Reference path: #1: (piping\_component\_definition <=  
product\_definition  
{piping\_component\_definition  
classification\_item = piping\_component\_definition  
classification\_item <=  
applied\_classification\_assignment.items[i]  
applied\_classification\_assignment <=  
classification\_assignment  
classification\_assignment.assigned\_classification ->  
[group =>  
pipe\_closure\_fitting\_class]  
[group  
group.name = 'cap']}  
{product\_definition  
product\_definition.formation ->  
product\_definition\_formation  
product\_definition\_formation.of\_product ->  
[product  
classification\_item = product  
classification\_item <=  
applied\_classification\_assignment.items[i]  
applied\_classification\_assignment <=  
{classification\_assignment  
classification\_assignment.role ->  
group\_role  
group\_role.name = 'plant item type'}  
classification\_assignment  
classification\_assignment.assigned\_classification ->  
(group)  
(group <=  
group\_relationship.related\_group  
group\_relationship  
group\_relationship.relating\_group ->  
group)  
group.name = 'cap'}  
[product  
product.frame\_of\_reference[i] ->  
product\_context<=  
application\_context\_element  
application\_context\_element.name = 'plant item']})  
#2: (piping\_component\_class <=  
[characterized\_object]  
[group])  
{[group =>  
pipe\_closure\_fitting\_class]  
[(group)  
(group <=  
group\_relationship.related\_group

```

group_relationship
group_relationship.relatng_group ->
group)
group.name = 'cap']}]

```

### 5.1.9.7.1 height

#1: The attributes are for the individual piping component.

#2: The attributes are for the definition of a family of piping components.

AIM element: [measure\_with\_unit.value\_component]  
[measure\_with\_unit.unit\_component]

Source: 41

Rules: subtype\_exclusive\_characterized\_object  
subtype\_mandatory\_shape\_representation

Reference path: #1: (piping\_component\_definition <=  
product\_definition  
characterized\_product\_definition = product\_definition  
characterized\_product\_definition  
characterized\_definition = characterized\_product\_definition  
characterized\_definition <=  
property\_definition.definition  
property\_definition =>  
product\_definition\_shape <=  
shape\_aspect.of\_shape  
[shape\_aspect <=  
shape\_aspect\_relationship.relatng\_shape\_aspect]  
[shape\_aspect <=  
shape\_aspect\_relationship.related\_shape\_aspect]  
shape\_aspect\_relationship =>  
dimensional\_location  
dimensional\_characteristic = dimensional\_location  
dimensional\_characteristic <=  
dimensional\_characteristic\_representation.dimension  
dimensional\_characteristic\_representation  
dimensional\_characteristic\_representation.representation ->  
shape\_dimension\_representation <=  
shape\_representation <=  
{representation  
representation.name = 'pipe closure fitting dimensional shape'}  
representation  
representation.items[i] ->  
{representation\_item  
representation\_item.name = 'height'})  
#2: (piping\_component\_class <=  
characterized\_object  
characterized\_definition = characterized\_object  
characterized\_definition <=  
property\_definition.definition  
property\_definition

```

represented_definition = property_definition
represented_definition <-
property_definition_representation.definition
property_definition_representation
property_definition_representation.used_representation ->
{representation
representation.name = 'pipe closure fitting class dimensions'}
representation
(representation.items[i] ->
{representation_item
(representation_item.name = 'maximum height')
(representation_item.name = 'minimum height'}})
([representation.items[i] ->
{representation_item
representation_item.name = 'maximum height'}]
[representation.items[i] ->
{representation_item
representation_item.name = 'minimum height'}}]))
representation_item =>
measure_representation_item <=
{measure_with_unit =>
length_measure_with_unit}
measure_with_unit
[measure_with_unit.value_component]
[measure_with_unit.unit_component]

```

### 5.1.9.8 Compound\_bend\_pipe

AIM element:	piping_component_definition
Source:	227
Rules:	dependent_instantiable_product_context product_context_discipline_type_constraint value_for_application_context
Reference path:	<pre> piping_component_definition &lt;= product_definition {piping_component_definition classification_item = piping_component_definition classification_item &lt;- applied_classification_assignment.items[i] applied_classification_assignment &lt;= classification_assignment classification_assignment.assigned_classification -&gt; [group =&gt; pipe_class] [group group.name = 'compound bend pipe']} {product_definition &lt;- product_definition_relationship.relateing_product_definition {[product_definition_relationship product_definition_relationship.name = 'compound bend pipe composition'] [product_definition_relationship </pre>

```

product_definition_relationship.related_product_definition ->
product_definition =>
piping_component definition
classification_item = piping_component_definition
classification_item <-
applied_classification_assignment.items[i]
applied_classification_assignment <=
classification_assignment
classification_assignment.assigned_classification ->
[group =>
pipe_class]
[group
(group.name = 'mitre bend pipe')
(group.name = 'swept bend pipe')
(group.name = 'straight pipe')]]}
{product_definition
product_definition.formation ->
product_definition_formation
product_definition_formation.of_product ->
[product
classification_item = product
classification_item <-
applied_classification_assignment.items[i]
applied_classification_assignment <=
{classification_assignment
classification_assignment.role ->
group_role
group_role.name = 'plant item type'}
classification_assignment
classification_assignment.assigned_classification ->
(group)
(group <-
group_relationship.related_group
group_relationship
group_relationship.relating_group ->
group)
group.name = 'pipe']
[product
product.frame_of_reference[i] ->
product_context<=
application_context_element
application_context_element.name = 'plant item']]

```

### 5.1.9.9 Coupling

#1: The attributes are for the individual piping component.

#2: The attributes are for the definition of a family of piping components.

AIM element:       #1: (piping\_component\_definition)  
                       #2: (piping\_component\_class)

Source:             227

Rules:              dependent\_instantiable\_product\_context

product\_context\_discipline\_type\_constraint  
value\_for\_application\_context

Reference path: #1: (piping\_component\_definition <=  
product\_definition  
{product\_definition  
product\_definition.formation ->  
product\_definition\_formation  
product\_definition\_formation.of\_product ->  
[product  
classification\_item = product  
classification\_item <-  
applied\_classification\_assignment.items[i]  
applied\_classification\_assignment <=  
classification\_assignment  
classification\_assignment.assigned\_classification ->  
(group)  
(group <-  
group\_relationship.related\_group  
group\_relationship  
group\_relationship.relying\_group ->  
group)  
group.name = 'coupling']  
[product  
product.frame\_of\_reference[i] ->  
product\_context<=  
application\_context\_element  
application\_context\_element.name = 'plant item']})  
#2: (piping\_component\_class <=  
[characterized\_object]  
[group])  
227

### 5.1.9.9.1 end\_1\_connector

AIM element: plant\_item\_connector

Source: 227

Reference path: piping\_component\_definition <=  
product\_definition  
characterized\_product\_definition = product\_definition  
characterized\_product\_definition  
characterized\_definition = characterized\_product\_definition  
characterized\_definition <-  
property\_definition.definition  
property\_definition =>  
product\_definition\_shape <-  
shape\_aspect.of\_shape  
{shape\_aspect  
shape\_aspect.description = 'end 1'}  
shape\_aspect =>  
plant\_item\_connector

### 5.1.9.9.2 **end\_2\_connector**

AIM element: plant\_item\_connector

Source: 227

Reference path: piping\_component\_definition <=  
 product\_definition  
 characterized\_product\_definition = product\_definition  
 characterized\_product\_definition  
 characterized\_definition = characterized\_product\_definition  
 characterized\_definition <=  
 property\_definition.definition  
 property\_definition =>  
 product\_definition\_shape <=  
 shape\_aspect.of\_shape  
 {shape\_aspect  
 shape\_aspect.description = 'end 2'}  
 shape\_aspect =>  
 plant\_item\_connector

### 5.1.9.9.3 **end\_to\_end\_length**

#1: The attributes are for the individual piping component.

#2: The attributes are for the definition of a family of piping components.

AIM element: [measure\_with\_unit.value\_component]  
 [measure\_with\_unit.unit\_component]

Source: 41

Rules: subtype\_exclusive\_characterized\_object  
 subtype\_mandatory\_shape\_representation

Reference path: #1: (piping\_component\_definition <=  
 product\_definition  
 characterized\_product\_definition = product\_definition  
 characterized\_product\_definition  
 characterized\_definition = characterized\_product\_definition  
 characterized\_definition <=  
 property\_definition.definition  
 property\_definition =>  
 product\_definition\_shape <=  
 shape\_aspect.of\_shape  
 {[shape\_aspect =>  
 plant\_item\_connector]  
 [shape\_aspect  
 shape\_aspect.description = 'end 1']}  
 shape\_aspect <=  
 shape\_aspect\_relationship.relating\_shape\_aspect]  
 {[shape\_aspect =>  
 plant\_item\_connector]  
 [shape\_aspect

```

shape_aspect.description = 'end 2']}]
shape_aspect <-
shape_aspect_relationship.related_shape_aspect]
shape_aspect_relationship =>
dimensional_location
dimensional_characteristic = dimensional_location
dimensional_characteristic <-
dimensional_characteristic_representation.dimension
dimensional_characteristic_representation
dimensional_characteristic_representation.representation ->
shape_dimension_representation <=
shape_representation <=
{representation
representation.name = 'coupling fitting dimensional shape'}
representation
representation.items[i] ->
{representation_item
representation_item.name = 'end to end length'}}
#2: (piping_component_class <=
characterized_object
characterized_definition = characterized_object
characterized_definition <-
property_definition.definition
property_definition
represented_definition = property_definition
represented_definition <-
property_definition_representation.definition
property_definition_representation
property_definition_representation.used_representation ->
{representation
representation.name = 'coupling fitting class dimensions'}
representation
(representation.items[i] ->
{representation_item
(representation_item.name = 'maximum end to end length')
(representation_item.name = 'minimum end to end length'}})
([representation.items[i] ->
{representation_item
representation_item.name = 'maximum end to end length'}]
[representation.items[i] ->
{representation_item
representation_item.name = 'minimum end to end length'}}]))
representation_item =>
measure_representation_item <=
{measure_with_unit =>
length_measure_with_unit}
measure_with_unit
[measure_with_unit.value_component]
[measure_with_unit.unit_component]

```

### 5.1.9.10 Cross

#1: The attributes are for the individual piping component.

#2: The attributes are for the definition of a family of piping components.

AIM element: #1: (piping\_component\_definition)  
#2: (piping\_component\_class)

Source: 227

Rules: dependent\_instantiable\_product\_context  
product\_context\_discipline\_type\_constraint  
value\_for\_application\_context

Reference path: #1: (piping\_component\_definition <=  
product\_definition  
{product\_definition  
product\_definition.formation ->  
product\_definition\_formation  
product\_definition\_formation.of\_product ->  
[product  
classification\_item = product  
classification\_item <=  
applied\_classification\_assignment.items[i]  
applied\_classification\_assignment <=  
classification\_assignment  
classification\_assignment.assigned\_classification ->  
(group)  
(group <=  
group\_relationship.related\_group  
group\_relationship  
group\_relationship.relying\_group ->  
group)  
group.name = 'cross']  
[product  
product.frame\_of\_reference[i] ->  
product\_context<=  
application\_context\_element  
application\_context\_element.name = 'plant item']})  
#2: (piping\_component\_class <=  
[characterized\_object]  
[group])  
227

#### 5.1.9.10.1 centre\_to\_end\_1\_length

#1: The attributes are for the individual piping component.

#2: The attributes are for the definition of a family of piping components.

AIM element: [measure\_with\_unit.value\_component]  
[measure\_with\_unit.unit\_component]

Source: 41

Rules:                subtype\_exclusive\_characterized\_object  
                          subtype\_mandatory\_shape\_representation

Reference path:    #1: (piping\_component\_definition <=  
                          product\_definition  
                          characterized\_product\_definition = product\_definition  
                          characterized\_product\_definition  
                          characterized\_definition = characterized\_product\_definition  
                          characterized\_definition <=  
                          property\_definition.definition  
                          property\_definition =>  
                          product\_definition\_shape <=  
                          [shape\_aspect.of\_shape  
                          {shape\_aspect  
                          shape\_aspect.description = 'centre'}  
                          shape\_aspect <=  
                          shape\_aspect\_relationship.relate\_shape\_aspect]  
                          [shape\_aspect.of\_shape  
                          {[shape\_aspect =>  
                          plant\_item\_connector]  
                          [shape\_aspect  
                          shape\_aspect.description = 'end 1']}]  
                          shape\_aspect <=  
                          shape\_aspect\_relationship.related\_shape\_aspect]  
                          shape\_aspect\_relationship =>  
                          dimensional\_location  
                          dimensional\_characteristic = dimensional\_location  
                          dimensional\_characteristic <=  
                          dimensional\_characteristic\_representation.dimension  
                          dimensional\_characteristic\_representation  
                          dimensional\_characteristic\_representation.representation ->  
                          shape\_dimension\_representation <=  
                          shape\_representation <=  
                          {representation  
                          representation.name = 'cross fitting dimensional shape'}  
                          representation  
                          representation.items[i] ->  
                          {representation\_item  
                          representation\_item.name = 'centre to end 1 length'}}  
                          #2: (piping\_component\_class <=  
                          characterized\_object  
                          characterized\_definition = characterized\_object  
                          characterized\_definition <=  
                          property\_definition.definition  
                          property\_definition  
                          represented\_definition = property\_definition  
                          represented\_definition <=  
                          property\_definition\_representation.definition  
                          property\_definition\_representation  
                          property\_definition\_representation.used\_representation ->  
                          {representation  
                          representation.name = 'cross fitting class dimensions'}  
                          representation  
                          (representation.items[i] ->

```

{representation_item
(representation_item.name = 'maximum centre to end 1 length')
(representation_item.name = 'minimum centre to end 1 length'))
([representation.items[i] ->
{representation_item
representation_item.name = 'maximum centre to end 1 length'}}
[representation.items[i] ->
{representation_item
representation_item.name = 'minimum centre to end 1 length'}})])
representation_item =>
measure_representation_item <=
{measure_with_unit =>
length_measure_with_unit}
measure_with_unit
[measure_with_unit.value_component]
[measure_with_unit.unit_component]

```

### 5.1.9.10.2 centre\_to\_end\_2\_length

#1: The attributes are for the individual piping component.

#2: The attributes are for the definition of a family of piping components.

AIM element: [measure\_with\_unit.value\_component]  
[measure\_with\_unit.unit\_component]

Source: 41

Rules: subtype\_exclusive\_characterized\_object  
subtype\_mandatory\_shape\_representation

Reference path: #1: (piping\_component\_definition <=  
product\_definition  
characterized\_product\_definition = product\_definition  
characterized\_product\_definition  
characterized\_definition = characterized\_product\_definition  
characterized\_definition <-  
property\_definition.definition  
property\_definition =>  
product\_definition\_shape <-  
[shape\_aspect.of\_shape  
{shape\_aspect  
shape\_aspect.description = 'centre'}  
shape\_aspect <-  
shape\_aspect\_relationship.relying\_shape\_aspect]  
[shape\_aspect.of\_shape  
{[shape\_aspect =>  
plant\_item\_connector]  
[shape\_aspect  
shape\_aspect.description = 'end 2']}]  
shape\_aspect <-  
shape\_aspect\_relationship.related\_shape\_aspect]  
shape\_aspect\_relationship =>  
dimensional\_location

```

dimensional_characteristic = dimensional_location
dimensional_characteristic <-
dimensional_characteristic_representation.dimension
dimensional_characteristic_representation
dimensional_characteristic_representation.representation ->
shape_dimension_representation <=
shape_representation <=
{representation
representation.name = 'cross fitting dimensional shape'}

representation
representation.items[i] ->
{representation_item
representation_item.name = 'centre to end 2 length'}}
#2: (piping_component_class <=
characterized_object
characterized_definition = characterized_object
characterized_definition <-
property_definition.definition
property_definition
represented_definition = property_definition
represented_definition <-
property_definition_representation.definition
property_definition_representation
property_definition_representation.used_representation ->
{representation
representation.name = 'cross fitting class dimensions'}
representation
(representation.items[i] ->
{representation_item
(representation_item.name = 'maximum centre to end 2 length')
(representation_item.name = 'minimum centre to end 2 length'}})
([representation.items[i] ->
{representation_item
representation_item.name = 'maximum centre to end 2 length'}}
[representation.items[i] ->
{representation_item
representation_item.name = 'minimum centre to end 2 length'}})])
representation_item =>
measure_representation_item <=
{measure_with_unit =>
length_measure_with_unit}
measure_with_unit
[measure_with_unit.value_component]
[measure_with_unit.unit_component]

```

### 5.1.9.10.3 centre\_to\_end\_3\_length

#1: The attributes are for the individual piping component.

#2: The attributes are for the definition of a family of piping components.

AIM element: [measure\_with\_unit.value\_component]

[measure\_with\_unit.unit\_component]

Source: 41

Rules: subtype\_exclusive\_characterized\_object  
subtype\_mandatory\_shape\_representation

Reference path: #1: (piping\_component\_definition <=  
product\_definition  
characterized\_product\_definition = product\_definition  
characterized\_product\_definition  
characterized\_definition = characterized\_product\_definition  
characterized\_definition <=  
property\_definition.definition  
property\_definition =>  
product\_definition\_shape <=  
[shape\_aspect.of\_shape  
{shape\_aspect  
shape\_aspect.description = 'centre'}  
shape\_aspect <=  
shape\_aspect\_relationship.relying\_shape\_aspect]  
[shape\_aspect.of\_shape  
{[shape\_aspect =>  
plant\_item\_connector]  
[shape\_aspect  
shape\_aspect.description = 'end 3']}]  
shape\_aspect <=  
shape\_aspect\_relationship.related\_shape\_aspect]  
shape\_aspect\_relationship =>  
dimensional\_location  
dimensional\_characteristic = dimensional\_location  
dimensional\_characteristic <=  
dimensional\_characteristic\_representation.dimension  
dimensional\_characteristic\_representation  
dimensional\_characteristic\_representation.representation ->  
shape\_dimension\_representation <=  
shape\_representation <=  
{representation  
representation.name = 'cross fitting dimensional shape'}  
representation  
representation.items[i] ->  
{representation\_item  
representation\_item.name = 'centre to end 3 length'})  
#2: (piping\_component\_class <=  
characterized\_object  
characterized\_definition = characterized\_object  
characterized\_definition <=  
property\_definition.definition  
property\_definition  
represented\_definition = property\_definition  
represented\_definition <=  
property\_definition\_representation.definition  
property\_definition\_representation  
property\_definition\_representation.used\_representation ->

```

{representation
representation.name = 'cross fitting class dimensions'}
representation
(representation.items[i] ->
{representation_item
(representation_item.name = 'maximum centre to end 3 length')
(representation_item.name = 'minimum centre to end 3 length'}})
([representation.items[i] ->
{representation_item
representation_item.name = 'maximum centre to end 3 length'}}
[representation.items[i] ->
{representation_item
representation_item.name = 'minimum centre to end 3 length'}}))
representation_item =>
measure_representation_item <=
{measure_with_unit =>
length_measure_with_unit}
measure_with_unit
[measure_with_unit.value_component]
[measure_with_unit.unit_component]
representation

```

#### 5.1.9.10.4 centre\_to\_end\_4\_length

#1: The attributes are for the individual piping component.

#2: The attributes are for the definition of a family of piping components.

AIM element: [measure\_with\_unit.value\_component]  
[measure\_with\_unit.unit\_component]

Source: 41

Rules: subtype\_exclusive\_characterized\_object  
subtype\_mandatory\_shape\_representation

Reference path: #1: (piping\_component\_definition <=
product\_definition
characterized\_product\_definition = product\_definition
characterized\_product\_definition
characterized\_definition = characterized\_product\_definition
characterized\_definition <-
property\_definition.definition
property\_definition =>
product\_definition\_shape <-
[shape\_aspect.of\_shape
{shape\_aspect
shape\_aspect.description = 'centre'}
shape\_aspect <-
shape\_aspect\_relationship.relate\_shape\_aspect]
[shape\_aspect.of\_shape
{[shape\_aspect =>
plant\_item\_connector]
[shape\_aspect

```

shape_aspect.description = 'end 4']}]
shape_aspect <-
shape_aspect_relationship.related_shape_aspect]
shape_aspect_relationship =>
dimensional_location
dimensional_characteristic = dimensional_location
dimensional_characteristic <-
dimensional_characteristic_representation.dimension
dimensional_characteristic_representation
dimensional_characteristic_representation.representation ->
shape_dimension_representation <=
shape_representation <=
{representation
representation.name = 'cross fitting dimensional shape'}

representation
representation.items[i] ->
{representation_item
representation_item.name = 'centre to end 4 length'}}
#2: (piping_component_class <=
characterized_object
characterized_definition = characterized_object
characterized_definition <-
property_definition.definition
property_definition
represented_definition = property_definition
represented_definition <-
property_definition_representation.definition
property_definition_representation
property_definition_representation.used_representation ->
{representation
representation.name = 'cross fitting class dimensions'}
representation
(representation.items[i] ->
{representation_item
(representation_item.name = 'maximum centre to end 4 length')
(representation_item.name = 'minimum centre to end 4 length'}})
([representation.items[i] ->
{representation_item
representation_item.name = 'maximum centre to end 4 length'}}
[representation.items[i] ->
{representation_item
representation_item.name = 'minimum centre to end 4 length'}})])
representation_item =>
measure_representation_item <=
{measure_with_unit =>
length_measure_with_unit}
measure_with_unit
[measure_with_unit.value_component]
[measure_with_unit.unit_component]

```

#### 5.1.9.10.5 end\_1\_connector

AIM element: plant\_item\_connector

Source: 227

Reference path: piping\_component\_definition <=  
product\_definition  
characterized\_product\_definition = product\_definition  
characterized\_product\_definition  
characterized\_definition = characterized\_product\_definition  
characterized\_definition <=  
property\_definition.definition  
property\_definition =>  
product\_definition\_shape <=  
shape\_aspect.of\_shape  
{shape\_aspect  
shape\_aspect.description = 'end 1'}  
shape\_aspect =>  
plant\_item\_connector

#### 5.1.9.10.6 end\_2\_connector

AIM element: plant\_item\_connector

Source: 227

Reference path: piping\_component\_definition <=  
product\_definition  
characterized\_product\_definition = product\_definition  
characterized\_product\_definition  
characterized\_definition = characterized\_product\_definition  
characterized\_definition <=  
property\_definition.definition  
property\_definition =>  
product\_definition\_shape <=  
shape\_aspect.of\_shape  
{shape\_aspect  
shape\_aspect.description = 'end 2'}  
shape\_aspect =>  
plant\_item\_connector

#### 5.1.9.10.7 end\_3\_connector

AIM element: plant\_item\_connector

Source: 227

Reference path: piping\_component\_definition <=  
product\_definition  
characterized\_product\_definition = product\_definition  
characterized\_product\_definition  
characterized\_definition = characterized\_product\_definition  
characterized\_definition <=  
property\_definition.definition

```

property_definition =>
product_definition_shape <-
shape_aspect.of_shape
{shape_aspect
shape_aspect.description = 'end 3'}
shape_aspect =>
plant_item_connector

```

#### 5.1.9.10.8 end\_4\_connector

AIM element: plant\_item\_connector

Source: 227

Reference path:

```

piping_component_definition <=
product_definition
characterized_product_definition = product_definition
characterized_product_definition
characterized_definition = characterized_product_definition
characterized_definition <-
property_definition.definition
property_definition =>
product_definition_shape <-
shape_aspect.of_shape
{shape_aspect
shape_aspect.description = 'end 4'}
shape_aspect =>
plant_item_connector

```

#### 5.1.9.11 Dummy\_leg

AIM element: piping\_support\_definition

Source: 227

Rules:

```

dependent_instantiable_product_context
product_context_discipline_type_constraint
value_for_application_context

```

Reference path:

```

piping_support_definition <=
product_definition
{piping_support_definition
classification_item = piping_support_definition
classification_item <-
applied_classification_assignment.items[i]
applied_classification_assignment <=
classification_assignment
classification_assignment.assigned_classification ->
[group =>
piping_support_fitting_-class]
[group
group.name = 'dummy leg']}
{product_definition

```

```

product_definition.formation ->
product_definition_formation
product_definition_formation.of_product ->
[product
classification_item = product
classification_item <-
applied_classification_assignment.items[i]
applied_classification_assignment <=
classification_assignment
classification_assignment.assigned_classification ->
(group)
(group <-
group_relationship.related_group
group_relationship
group_relationship.relatng_group ->
group)
group.name = 'piping support']
[product
product.frame_of_reference[i] ->
product_context <=
application_context_element
application_context_element.name = 'plant item']]

```

#### 5.1.9.11.1 length

AIM element: [measure\_with\_unit.value\_component]  
[measure\_with\_unit.unit\_component]

Source: 41

Rules: subtype\_mandatory\_shape\_representation

Reference path: piping\_support\_definition <=

```

product_definition
characterized_product_definition = product_definition
characterized_product_definition
characterized_definition = characterized_product_definition
characterized_definition <-
property_definition.definition
property_definition =>
product_definition_shape <-
shape_aspect.of_shape
[shape_aspect <-
shape_aspect_relationship.relatng_shape_aspect]
[shape_aspect <-
shape_aspect_relationship.related_shape_aspect]
shape_aspect_relationship =>
dimensional_location
dimensional_characteristic = dimensional_location
dimensional_characteristic <-
dimensional_characteristic_representation.dimension
dimensional_characteristic_representation
dimensional_characteristic_representation.representation ->
shape_dimension_representation <=

```

```

shape_representation <=
{representation
representation.name = 'dummy leg dimensional shape'}
representation
representation.items[i] ->
representation_item =>
{representation_item.name = 'length'}
measure_representation_item <=
{measure_with_unit =>
length_measure_with_unit}
measure_with_unit
[measure_with_unit.value_component]
[measure_with_unit.unit_component]

```

### 5.1.9.12 Eccentric\_base\_elbow\_support

AIM element:	piping_support_definition
Source:	227
Rules:	dependent_instantiable_product_context product_context_discipline_type_constraint value_for_application_context
Reference path:	<pre> piping_support_definition &lt;= product_definition {piping_support_definition classification_item = piping_support_definition classification_item &lt;- applied_classification_assignment.items[i] applied_classification_assignment &lt;= classification_assignment classification_assignment.assigned_classification -&gt; [group =&gt; piping_support_fitting_-class] [group group.name = 'eccentric base elbow support']} {product_definition product_definition.formation -&gt; product_definition_formation product_definition_formation.of_product -&gt; [product classification_item = product classification_item &lt;- applied_classification_assignment.items[i] applied_classification_assignment &lt;= classification_assignment classification_assignment.assigned_classification -&gt; (group) (group &lt;- group_relationship.related_group group_relationship group_relationship.relate_group -&gt; group) </pre>

```

group.name = 'piping support']
[product
product.frame_of_reference[i] ->
product_context <=
application_context_element
application_context_element.name = 'plant item']]

```

### 5.1.9.12.1 offset

AIM element: [measure\_with\_unit.value\_component]  
[measure\_with\_unit.unit\_component]

Source: 41

Rules: subtype\_mandatory\_shape\_representation

Reference path

```

piping_support_definition <=
product_definition
characterized_product_definition = product_definition
characterized_product_definition
characterized_definition = characterized_product_definition
characterized_definition <-
property_definition.definition
property_definition =>
product_definition_shape <-
shape_aspect.of_shape
[{shape_aspect.description = 'location point'}
shape_aspect <-
shape_aspect_relationship.relate_shape_aspect]
[{shape_aspect.description = 'centreline'}
shape_aspect <-
shape_aspect_relationship.related_shape_aspect]
shape_aspect_relationship =>
dimensional_location
dimensional_characteristic = dimensional_location
dimensional_characteristic <-
dimensional_characteristic_representation.dimensional
dimensional_characteristic_representation
dimensional_characteristic_representation.representation ->
shape_dimension_representation <=
shape_representation <=
{representation
representation.name = 'eccentric base elbow support dimensional shape'}
representation
representation.items[i] ->
representation_item =>
{representation_item.name = 'offset'}
measure_representation_item <=
{measure_with_unit =>
length_measure_with_unit}
measure_with_unit
[measure_with_unit.value_component]
[measure_with_unit.unit_component]

```

**5.1.9.12.2 root\_orientation**

AIM element: axis2\_placement\_3d.ref\_direction

Source: 42

Reference path: product  
 product\_definition\_formation.of\_product  
 product\_definition\_formation  
 product\_definition.formation  
 product\_definition  
 characterized\_product\_definition = product\_definition  
 characterized\_product\_definition  
 characterized\_definition = characterized\_product\_definition  
 characterized\_definition <-  
 property\_definition.definition  
 property\_definition =>  
 product\_definition\_shape <-  
 shape\_aspect.of\_shape  
 shape\_aspect  
 represented\_definition = shape\_aspect  
 represented\_definition <-  
 property\_definition\_representation.definition  
 property\_definition\_representation  
 property\_definition\_representation.used\_representation ->  
 representation  
 representation.items[i] ->  
 {representation\_item  
 representation\_item.name = 'root orientation'}  
 representation\_item =>  
 geometric\_representation\_item =>  
 placement =>  
 axis2\_placement\_3d  
 axis2\_placement\_3d.ref\_direction

**5.1.9.13 Eccentric\_reducer**

AIM element: piping\_component\_definition

Source: 227

Rules: dependent\_instantiable\_product\_context  
 product\_context\_discipline\_type\_constraint  
 value\_for\_application\_context

Reference path: piping\_component\_definition <=  
 product\_definition  
 {piping\_component\_definition  
 classification\_item = piping\_component\_definition  
 classification\_item <-  
 applied\_classification\_assignment.items[i]  
 applied\_classification\_assignment <=  
 classification\_assignment  
 classification\_assignment.assigned\_classification ->

```

[group =>
reducer_fitting_class]
[group
group.name = 'eccentric reducer']]
{product_definition
product_definition.formation ->
product_definition_formation
product_definition_formation.of_product ->
[product
classification_item = product
classification_item <-
applied_classification_assignment.items[i]
applied_classification_assignment <=
classification_assignment
classification_assignment.assigned_classification ->
(group)
(group <-
group_relationship.related_group
group_relationship
group_relationship.relying_group ->
group)
group.name = 'reducer']
[product
product.frame_of_reference[i] ->
product_context<=
application_context_element
application_context_element.name = 'plant item']]

```

#### 5.1.9.13.1 centreline\_offset

AIM element: [measure\_with\_unit.value\_component]  
[measure\_with\_unit.unit\_component]

Source: 41

Rules: subtype\_mandatory\_shape\_representation

Reference path: piping\_component\_definition <=

```

product_definition
characterized_product_definition = product_definition
characterized_product_definition
characterized_definition = characterized_product_definition
characterized_definition <-
property_definition.definition
property_definition =>
product_definition_shape <-
[shape_aspect.of_shape
{shape_aspect shape_aspect.description = 'centre'}
shape_aspect <-
shape_aspect_relationship.relying_shape_aspect]
[shape_aspect.of_shape
{shape_aspect
shape_aspect.description = 'centre'}
shape_aspect <-

```

```

shape_aspect_relationship.related_shape_aspect]
shape_aspect_relationship =>
dimensional_location
dimensional_characteristic = dimensional_location
dimensional_characteristic <-
dimensional_characteristic_representation.dimension
dimensional_characteristic_representation
dimensional_characteristic_representation.representation ->
shape_dimension_representation <=
shape_representation <=
{representation
representation.name = 'reducer fitting dimensional shape'}
representation
representation.items[i] ->
{representation_item
representation_item.name = 'centreline offset'}
representation_item =>
measure_representation_item <=

{measure_with_unit =>
length_measure_with_unit}
measure_with_unit
[measure_with_unit.value_component]
[measure_with_unit.unit_component]

```

### 5.1.9.13.2 flat\_side\_orientation

AIM element: shape\_aspect.description

Source: 41

Reference path:

```

piping_component_definition <=
product_definition
characterized_product_definition = product_definition
characterized_product_definition
characterized_definition = characterized_product_definition
characterized_definition <-
property_definition.definition
property_definition =>
product_definition_shape <-
shape_aspect.of_shape
{shape_aspect
shape_aspect.name = 'flat side'}
shape_aspect

```

### 5.1.9.14 Elbow

#1: The attributes are for the individual piping component.

#2: The attributes are for the definition of a family of piping components.

AIM element: #1: (piping\_component\_definition)

#2: (piping\_component\_class)

Source: 227

Rules: dependent\_instantiable\_product\_context  
product\_context\_discipline\_type\_constraint  
value\_for\_application\_context

Reference path: #1: (piping\_component\_definition <=  
product\_definition  
{product\_definition  
product\_definition.formation ->  
product\_definition\_formation  
product\_definition\_formation.of\_product ->  
[product  
classification\_item = product  
classification\_item <=  
applied\_classification\_assignment.items[i]  
applied\_classification\_assignment <=  
classification\_assignment  
classification\_assignment.assigned\_classification ->  
(group)  
(group <=  
group\_relationship.related\_group  
group\_relationship  
group\_relationship.relatng\_group ->  
group)  
group.name = 'elbow']  
[product  
product.frame\_of\_reference[i] ->  
product\_context<=  
application\_context\_element  
application\_context\_element.name = 'plant item']})  
#2: (piping\_component\_class <=  
[characterized\_object]  
[group])  
227

#### 5.1.9.14.1 centre\_to\_end\_1\_length

#1: The attributes are for the individual piping component.

#2: The attributes are for the definition of a family of piping components.

AIM element: [measure\_with\_unit.value\_component]  
[measure\_with\_unit.unit\_component]

Source: 41

Rules: subtype\_exclusive\_characterized\_object  
subtype\_mandatory\_shape\_representation

Reference path: #1: (piping\_component\_definition <=  
product\_definition

```

characterized_product_definition = product_definition
characterized_product_definition
characterized_definition = characterized_product_definition
characterized_definition <-
property_definition.definition
property_definition =>
product_definition_shape <-
[shape_aspect.of_shape
{shape_aspect
shape_aspect.description = 'centre'}
shape_aspect <-
shape_aspect_relationship.relateing_shape_aspect]
[shape_aspect.of_shape
{[shape_aspect =>
plant_item_connector]
[shape_aspect
shape_aspect.description = 'end 1']}
shape_aspect <-
shape_aspect_relationship.related_shape_aspect]
shape_aspect_relationship =>
dimensional_location
dimensional_characteristic = dimensional_location
dimensional_characteristic <-
dimensional_characteristic_representation.dimension
dimensional_characteristic_representation
dimensional_characteristic_representation.representation ->
shape_dimension_representation <=
shape_representation <=
{representation
representation.name = 'elbow fitting dimensional shape'}
representation
representation.items[i] ->
{representation_item
representation_item.name = 'centre to end 1 length'})
#2: (piping_component_class <=
characterized_object
characterized_definition = characterized_object
characterized_definition <-
property_definition.definition
property_definition
represented_definition = property_definition
represented_definition <-
property_definition_representation.definition
property_definition_representation
property_definition_representation.used_representation ->
{representation
representation.name = 'elbow fitting class dimensions'}
representation
(representation.items[i] ->
{representation_item
(representation_item.name = 'maximum centre to end 1 length')
(representation_item.name = 'minimum centre to end 1 length')}}
([representation.items[i] ->
{representation_item

```

```

representation_item.name = 'maximum centre to end 1 length'}}
[representation.items[i] ->
{representation_item
representation_item.name = 'minimum centre to end 1 length'}}))
representation_item =>
measure_representation_item <=
{measure_with_unit =>
length_measure_with_unit}
measure_with_unit
[measure_with_unit.value_component]
[measure_with_unit.unit_component]

```

### 5.1.9.14.2 centre\_to\_end\_2\_length

#1: The attributes are for the individual piping component.

#2: The attributes are for the definition of a family of piping components.

AIM element: [measure\_with\_unit.value\_component]  
[measure\_with\_unit.unit\_component]

Source: 41

Rules: subtype\_exclusive\_characterized\_object  
subtype\_mandatory\_shape\_representation

Reference path: #1: (piping\_component\_definition <=  
product\_definition  
characterized\_product\_definition = product\_definition  
characterized\_product\_definition  
characterized\_definition = characterized\_product\_definition  
characterized\_definition <=  
property\_definition.definition  
property\_definition =>  
product\_definition\_shape <=  
[shape\_aspect.of\_shape  
{shape\_aspect  
shape\_aspect.description = 'centre'}  
shape\_aspect <=  
shape\_aspect\_relationship.relying\_shape\_aspect]  
[shape\_aspect.of\_shape  
{[shape\_aspect =>  
plant\_item\_connector]  
[shape\_aspect  
shape\_aspect.description = 'end 2']}]  
shape\_aspect <=  
shape\_aspect\_relationship.related\_shape\_aspect]  
shape\_aspect\_relationship =>  
dimensional\_location  
dimensional\_characteristic = dimensional\_location  
dimensional\_characteristic <=  
dimensional\_characteristic\_representation.dimension  
dimensional\_characteristic\_representation  
dimensional\_characteristic\_representation.representation ->

```

shape_dimension_representation <=
shape_representation <=
{representation
representation.name = 'elbow fitting dimensional shape'}
representation
representation.items[i] ->
{representation_item
representation_item.name = 'centre to end 2 length'}}
#2: (piping_component_class <=
characterized_object
characterized_definition = characterized_object
characterized_definition <-
property_definition.definition
property_definition
represented_definition = property_definition
represented_definition <-
property_definition_representation.definition
property_definition_representation
property_definition_representation.used_representation ->
{representation
representation.name = 'elbow fitting class dimensions'}
representation
(representation.items[i] ->
{representation_item
(representation_item.name = 'maximum centre to end 2 length')
(representation_item.name = 'minimum centre to end 2 length'}})
([representation.items[i] ->
{representation_item
representation_item.name = 'maximum centre to end 2 length'}}
[representation.items[i] ->
{representation_item
representation_item.name = 'minimum centre to end 2 length'}}]))
representation_item =>
measure_representation_item <=
{measure_with_unit =>
length_measure_with_unit}
measure_with_unit
[measure_with_unit.value_component]
[measure_with_unit.unit_component]

```

### 5.1.9.14.3 centreline\_radius

#1: The attributes are for the individual piping component.

#2: The attributes are for the definition of a family of piping components.

AIM element: [measure\_with\_unit.value\_component]  
[measure\_with\_unit.unit\_component]

Source: 41

Rules: subtype\_exclusive\_characterized\_object  
subtype\_mandatory\_shape\_representation

```

Reference path:  #1: (piping_component_definition <=
                  product_definition
                  characterized_product_definition = product_definition
                  characterized_product_definition
                  characterized_definition = characterized_product_definition
                  characterized_definition <-
                  property_definition.definition
                  property_definition =>
                  product_definition_shape <-
                  [shape_aspect.of_shape
                  {shape_aspect shape_aspect.description = 'inner bend centre point'}
                  shape_aspect <-
                  shape_aspect_relationship.relating_shape_aspect]
                  [shape_aspect.of_shape
                  {shape_aspect shape_aspect.name = 'sweep angle centre point'}
                  shape_aspect <-
                  shape_aspect_relationship.related_shape_aspect]
                  shape_aspect_relationship =>
                  dimensional_location
                  dimensional_characteristic = dimensional_location
                  dimensional_characteristic <-
                  dimensional_characteristic_representation.dimension
                  dimensional_characteristic_representation
                  dimensional_characteristic_representation.representation ->
                  shape_dimension_representation <=
                  shape_representation <=
                  {representation
                  representation.name = 'elbow fitting dimensional shape'}
                  representation
                  representation.items[i] ->
                  {representation_item
                  representation_item.name = 'centreline radius'
                  #2:(piping_component_class <=
                  characterized_object
                  characterized_definition = characterized_object
                  characterized_definition <-
                  property_definition.definition
                  property_definition
                  represented_definition = property_definition
                  represented_definition <-
                  property_definition_representation.definition
                  property_definition_representation
                  property_definition_representation.used_representation ->
                  {representation
                  representation.name = 'elbow fitting class dimensions'}
                  representation
                  (representation.items[i] ->
                  {representation_item
                  (representation_item.name = 'maximum centreline radius')
                  (representation_item.name = 'minimum centreline radius'}})
                  ([representation.items[i] ->
                  {representation_item
                  representation_item.name = 'maximum centreline radius'}}]
                  [representation.items[i] ->

```

```

{representation_item
representation_item.name = 'minimum centreline radius'}}))
representation_item =>
measure_representation_item <=
{measure_with_unit =>
length_measure_with_unit}
measure_with_unit
[measure_with_unit.value_component]
[measure_with_unit.unit_component]

```

#### 5.1.9.14.4 end\_1\_connector

AIM element: plant\_item\_connector

Source: 227

Reference path:

```

piping_component_definition <=
product_definition
characterized_product_definition = product_definition
characterized_product_definition
characterized_definition = characterized_product_definition
characterized_definition <-
property_definition.definition
property_definition =>
product_definition_shape <-
shape_aspect.of_shape
{shape_aspect
shape_aspect.description = 'end 1'}
shape_aspect =>
plant_item_connector

```

#### 5.1.9.14.5 end\_2\_connector

AIM element: plant\_item\_connector

Source: 227

Reference path:

```

piping_component_definition <=
product_definition
characterized_product_definition = product_definition
characterized_product_definition
characterized_definition = characterized_product_definition
characterized_definition <-
property_definition.definition
property_definition =>
product_definition_shape <-
shape_aspect.of_shape
{shape_aspect
shape_aspect.description = 'end 2'}
shape_aspect =>
plant_item_connector

```

**5.1.9.14.6 sweep\_angle**

#1: The attributes are for the individual piping component.

#2: The attributes are for the definition of a family of piping components.

AIM element: [measure\_with\_unit.value\_component]  
[measure\_with\_unit.unit\_component]

Source: 41

Rules: subtype\_exclusive\_characterized\_object  
subtype\_mandatory\_shape\_representation

Reference path: #1: (piping\_component\_definition <=  
product\_definition  
characterized\_product\_definition = product\_definition  
characterized\_product\_definition  
characterized\_definition = characterized\_product\_definition  
characterized\_definition <=  
property\_definition.definition  
property\_definition =>  
product\_definition\_shape <=  
shape\_aspect.of\_shape  
[shape\_aspect <=  
shape\_aspect\_relationship.relate\_shape\_aspect]  
[shape\_aspect <=  
shape\_aspect\_relationship.related\_shape\_aspect]  
shape\_aspect\_relationship =>  
{dimensional\_location =>  
angular\_location}  
dimensional\_location  
dimensional\_characteristic = dimensional\_location  
dimensional\_characteristic <=  
dimensional\_characteristic\_representation.dimension  
dimensional\_characteristic\_representation  
dimensional\_characteristic\_representation.representation ->  
shape\_dimension\_representation <=  
shape\_representation <=  
{representation  
representation.name = 'elbow fitting dimensional shape'}  
representation  
representation.items[i] ->  
{representation\_item  
representation\_item.name = 'sweep angle'})  
#2: (piping\_component\_class <=  
characterized\_object  
characterized\_definition = characterized\_object  
characterized\_definition <=  
property\_definition.definition  
property\_definition  
represented\_definition = property\_definition  
represented\_definition <=  
property\_definition\_representation.definition

```

property_definition_representation
property_definition_representation.used_representation ->
{representation
representation.name = 'elbow fitting class dimensions'}
representation
(representation.items[i] ->
{representation_item
(representation_item.name = 'maximum sweep angle')
(representation_item.name = 'minimum sweep angle')}}
([representation.items[i] ->
{representation_item
representation_item.name = 'maximum sweep angle'}}
[representation.items[i] ->
{representation_item
representation_item.name = 'minimum sweep angle'}}]))
representation_item =>
measure_representation_item <=
{measure_with_unit =>
plane_angle_measure_with_unit}
measure_with_unit
[measure_with_unit.value_component]
[measure_with_unit.unit_component]

```

#### 5.1.9.14.7 type

AIM element: group.name

Source: 41

Reference path: piping\_component\_definition  
classification\_item = piping\_component\_definition  
classification\_item <-  
applied\_classification\_assignment.items[i]  
applied\_classification\_assignment <=  
{classification\_assignment  
classification\_assignment.role ->  
classification\_role  
classification\_role.name = 'elbow fitting type classification'}  
classification\_assignment  
classification\_assignment.assigned\_classification ->  
{group =>  
elbow\_fitting\_class}  
group  
group.name

#### 5.1.9.15 Expander\_flange

AIM element: piping\_component\_definition

Source: 227

Rules: dependent\_instantiable\_product\_context  
product\_context\_discipline\_type\_constraint

value\_for\_application\_context

Reference path: piping\_component\_definition <=  
 product\_definition  
 {piping\_component\_definition  
 classification\_item = piping\_component\_definition  
 classification\_item <=  
 applied\_classification\_assignment.items[i]  
 applied\_classification\_assignment <=  
 classification\_assignment  
 classification\_assignment.assigned\_classification ->  
 [group =>  
 flange\_fitting\_class]  
 [group  
 group.name = 'expander flange']}  
 {product\_definition  
 product\_definition.formation ->  
 product\_definition\_formation  
 product\_definition\_formation.of\_product ->  
 [product  
 classification\_item = product  
 classification\_item <=  
 applied\_classification\_assignment.items[i]  
 applied\_classification\_assignment <=  
 classification\_assignment  
 classification\_assignment.assigned\_classification ->  
 (group)  
 (group <=  
 group\_relationship.related\_group  
 group\_relationship  
 group\_relationship.relate\_group ->  
 group)  
 group.name = 'flange']  
 [product  
 product.frame\_of\_reference[i] ->  
 product\_context<=  
 application\_context\_element  
 application\_context\_element.name = 'plant item']]}

### 5.1.9.16 Family\_definition

AIM element: piping\_component\_class

Source: 227

Reference path: piping\_component\_class <=  
 [group]  
 [characterized\_object]

#### 5.1.9.16.1 family\_classification\_description

AIM element: group\_relationship.related\_group

Source: 41

Reference path: `piping_component_class <=`  
`group`  
`group_relationship.related_group`

### 5.1.9.17 Ferrule

#1: The attributes are for an individual piping component.

#2: The attributes are for the definition of a family of piping components.

AIM element: #1: (piping\_component\_definition)  
 #2: (piping\_component\_class)

Source: 227

Rules: `dependent_instantiable_product_context`  
`product_context_discipline_type_constraint`  
`value_for_application_context`

Reference path: #1: (piping\_component\_definition <=

```

product_definition
{product_definition
product_definition.formation ->
product_definition_formation
product_definition_formation.of_product ->
[product
classification_item = product
classification_item <-
applied_classification_assignment.items[i]
applied_classification_assignment <=
classification_assignment
classification_assignment.assigned_classification ->
(group)
(group <-
group_relationship.related_group
group_relationship
group_relationship.relate_group ->
group)
group.name = 'ferrule']
[product
product.frame_of_reference[i] ->
product_context<=
application_context_element
application_context_element.name = 'plant item']})
#2: (piping_component_class <=
[characterized_object]
[group])

```

#### 5.1.9.17.1 end\_1\_connector

AIM element: plant\_item\_connector

Source: 227

Reference path: piping\_component\_definition <=  
product\_definition  
characterized\_product\_definition = product\_definition  
characterized\_product\_definition  
characterized\_definition = characterized\_product\_definition  
characterized\_definition <=  
property\_definition.definition  
property\_definition =>  
product\_definition\_shape <=  
shape\_aspect.of\_shape  
{shape\_aspect  
shape\_aspect.description = 'end 1'}  
shape\_aspect =>  
plant\_item\_connector

### 5.1.9.17.2 end\_2\_connector

AIM element: plant\_item\_connector

Source: 227

Reference path: piping\_component\_definition <=  
product\_definition  
characterized\_product\_definition = product\_definition  
characterized\_product\_definition  
characterized\_definition = characterized\_product\_definition  
characterized\_definition <=  
property\_definition.definition  
property\_definition =>  
product\_definition\_shape <=  
shape\_aspect.of\_shape  
{shape\_aspect  
shape\_aspect.description = 'end 2'}  
shape\_aspect =>  
plant\_item\_connector

### 5.1.9.17.3 length

#1: The length is for the individual piping component.

#2: The length is for the definition of a family of piping components.

AIM element: [measure\_with\_unit.value\_component]  
[measure\_with\_unit.unit\_component]

Source: 41

Rules: subtype\_exclusive\_characterized\_object  
subtype\_mandatory\_shape\_representation

```

Reference path: #1: (piping_component_definition <=
product_definition
characterized_product_definition = product_definition
characterized_product_definition
characterized_definition = characterized_product_definition
characterized_definition <-
property_definition.definition
property_definition =>
product_definition_shape <-
shape_aspect.of_shape
[shape_aspect <-
shape_aspect_relationship.relate_shape_aspect]
[shape_aspect <-
shape_aspect_relationship.related_shape_aspect]
shape_aspect_relationship =>
dimensional_location
dimensional_characteristic = dimensional_location
dimensional_characteristic <-
dimensional_characteristic_representation.dimension
dimensional_characteristic_representation
dimensional_characteristic_representation.representation ->
shape_dimension_representation <=
shape_representation <=
{representation
representation.name = 'ferrule fitting dimensional shape'}
representation
representation.items[i] ->
{representation_item
representation_item.name = 'length'})
#2: (piping_component_class <=
characterized_object
characterized_definition = characterized_object
characterized_definition <-
property_definition.definition
property_definition
represented_definition = property_definition
represented_definition <-
property_definition_representation.definition
property_definition_representation
property_definition_representation.used_representation ->
{representation
representation.name = 'ferrule fitting class dimensions'}
representation
(representation.items[i] ->
{representation_item
(representation_item.name = 'maximum length')
(representation_item.name = 'minimum length'}})
([representation.items[i] ->
{representation_item
representation_item.name = 'maximum length'}]
[representation.items[i] ->
{representation_item
representation_item.name = 'minimum length'}}))
representation_item =>

```

```

measure_representation_item <=
{ measure_with_unit =>
length_measure_with_unit }
measure_with_unit
[measure_with_unit.value_component]
[measure_with_unit.unit_component]

```

### 5.1.9.18 Fitting

AIM element: (piping\_component\_definition)  
(piping\_component\_class)

Source: 227

Rules: dependent\_instantiable\_product\_context  
product\_context\_discipline\_type\_constraint  
value\_for\_application\_context

Reference path: (piping\_component\_definition <=  
product\_definition  
{ product\_definition  
product\_definition.formation ->  
product\_definition\_formation  
product\_definition\_formation.of\_product ->  
[product  
classification\_item = product  
classification\_item <=  
applied\_classification\_assignment.items[i]  
applied\_classification\_assignment <=  
classification\_assignment  
classification\_assignment.assigned\_classification ->  
(group)  
(group <=  
group\_relationship.related\_group  
group\_relationship  
group\_relationship.relate\_group ->  
group)  
group.name = 'fitting']  
[product  
product.frame\_of\_reference[i] ->  
product\_context<=  
application\_context\_element  
application\_context\_element.name = 'plant item']})  
(piping\_component\_class <=  
[characterized\_object]  
[group])  
227

### 5.1.9.19 Flange

#1: The attributes are for the individual piping component.

#2: The attributes are for the definition of a family of piping components.

AIM element: #1: (piping\_component\_definition)  
#2: (piping\_component\_class)

Source: 227

Rules: dependent\_instantiable\_product\_context  
product\_context\_discipline\_type\_constraint  
value\_for\_application\_context

Reference path: #1: (piping\_component\_definition <=  
product\_definition  
{product\_definition  
product\_definition.formation ->  
product\_definition\_formation  
product\_definition\_formation.of\_product ->  
[product  
classification\_item = product  
classification\_item <=  
applied\_classification\_assignment.items[i]  
applied\_classification\_assignment <=  
classification\_assignment  
classification\_assignment.assigned\_classification ->  
(group)  
(group <=  
group\_relationship.related\_group  
group\_relationship  
group\_relationship.relatng\_group ->  
group)  
group.name = 'flange']  
[product  
product.frame\_of\_reference[i] ->  
product\_context<=  
application\_context\_element  
application\_context\_element.name = 'plant item']})  
#2: (piping\_component\_class <=  
[characterized\_object]  
[group])  
227

#### 5.1.9.19.1 end\_1\_connector

AIM element: plant\_item\_connector

Source: 227

Reference path: piping\_component\_definition <=  
product\_definition  
characterized\_product\_definition = product\_definition  
characterized\_product\_definition  
characterized\_definition = characterized\_product\_definition  
characterized\_definition <=  
property\_definition.definition

```

property_definition =>
product_definition_shape <-
shape_aspect.of_shape
{shape_aspect
shape_aspect.description = 'end 1'}
shape_aspect =>
plant_item_connector

```

### 5.1.9.19.2 end\_2\_connector

AIM element: plant\_item\_connector

Source: 227

Reference path:

```

piping_component_definition <=
product_definition
characterized_product_definition = product_definition
characterized_product_definition
characterized_definition = characterized_product_definition
characterized_definition <-
property_definition.definition
property_definition =>
product_definition_shape <-
shape_aspect.of_shape
{shape_aspect
shape_aspect.description = 'end 2'}
shape_aspect =>
plant_item_connector

```

### 5.1.9.19.3 hub\_through\_length

#1: The attributes are for the individual piping component.

#2: The attributes are for the definition of a family of piping components.

AIM element: [measure\_with\_unit.value\_component]  
[measure\_with\_unit.unit\_component]

Source: 41

Rules: subtype\_exclusive\_characterized\_object  
subtype\_mandatory\_shape\_representation

Reference path:

```

#1: (piping_component_definition <=
product_definition
characterized_product_definition = product_definition
characterized_product_definition
characterized_definition = characterized_product_definition
characterized_definition <-
property_definition.definition
property_definition =>
product_definition_shape <-
shape_aspect.of_shape

```

```

[shape_aspect <-
shape_aspect_relationship.relatng_shape_aspect]
[shape_aspect <-
shape_aspect_relationship.related_shape_aspect]
shape_aspect_relationship =>
dimensional_location
dimensional_characteristic = dimensional_location
dimensional_characteristic <-
dimensional_characteristic_representation.dimension
dimensional_characteristic_representation
dimensional_characteristic_representation.representation ->
shape_dimension_representation <=
shape_representation <=
{representation
representation.name = 'flange fitting dimensional shape'}
representation
representation.items[i] ->
{representation_item
representation_item.name = 'hub through length'})
#2: (piping_component_class <=
characterized_object
characterized_definition = characterized_object
characterized_definition <-
property_definition.definition
property_definition
represented_definition = property_definition
represented_definition <-
property_definition_representation.definition
property_definition_representation
property_definition_representation.used_representation ->
{representation
representation.name = 'flange fitting class dimensions'}
representation
(representation.items[i] ->
{representation_item
(representation_item.name = 'maximum hub through length')
(representation_item.name = 'minimum hub through length'}})
([representation.items[i] ->
{representation_item
representation_item.name = 'maximum hub through length'}}
[representation.items[i] ->
{representation_item
representation_item.name = 'minimum hub through length'}}]))
representation_item =>
measure_representation_item <=
{measure_with_unit =>
length_measure_with_unit}
measure_with_unit
[measure_with_unit.value_component]
[measure_with_unit.unit_component]

```

#### 5.1.9.19.4 hub\_weld\_point\_diameter

#1: The attributes are for the individual piping component.

#2: The attributes are for the definition of a family of piping components.

AIM element: [measure\_with\_unit.value\_component]  
[measure\_with\_unit.unit\_component]

Source: 41

Rules: subtype\_exclusive\_characterized\_object  
subtype\_mandatory\_shape\_representation

Reference path: #1: (piping\_component\_definition <=  
product\_definition  
characterized\_product\_definition = product\_definition  
characterized\_product\_definition  
characterized\_definition = characterized\_product\_definition  
characterized\_definition <=  
property\_definition.definition  
property\_definition =>  
product\_definition\_shape <=  
shape\_aspect.of\_shape  
shape\_aspect <=  
dimensional\_size.applies\_to  
dimensional\_size  
dimensional\_characteristic = dimensional\_size  
dimensional\_characteristic <=  
dimensional\_characteristic\_representation.dimension  
dimensional\_characteristic\_representation  
dimensional\_characteristic\_representation.representation ->  
shape\_dimension\_representation <=  
shape\_representation <=  
{representation  
representation.name = 'flange fitting dimensional shape'}  
representation  
representation.items[i] ->  
{representation\_item  
representation\_item.name = 'hub weld point diameter'}}  
#2: (piping\_component\_class <=  
characterized\_object  
characterized\_definition = characterized\_object  
characterized\_definition <=  
property\_definition.definition  
property\_definition  
represented\_definition = property\_definition  
represented\_definition <=  
property\_definition\_representation.definition  
property\_definition\_representation  
property\_definition\_representation.used\_representation ->  
{representation  
representation.name = 'flange fitting class dimensions'}  
representation  
(representation.items[i] ->  
{representation\_item

```

(representation_item.name = 'maximum hub weld point diameter')
(representation_item.name = 'minimum hub weld point diameter'))
([representation.items[i] ->
 {representation_item
 representation_item.name = 'maximum hub weld point diameter'}}
 [representation.items[i] ->
 {representation_item
 representation_item.name = 'minimum hub weld point diameter'}}))
representation_item =>
measure_representation_item <=
 {measure_with_unit =>
 length_measure_with_unit}
measure_with_unit
 [measure_with_unit.value_component]
 [measure_with_unit.unit_component]

```

### 5.1.9.19.5 hole\_straddle\_centreline\_orientation

#1: The attributes are for the individual piping component.

#2: The attributes are for the definition of a family of piping components.

AIM element: axis2\_placement\_3d

Source: 42

Reference path: #1: (piping\_component\_definition <=

```

product_definition
characterized_product_definition = product_definition
characterized_product_definition
characterized_definition = characterized_product_definition
characterized_definition <-
property_definition.definition
property_definition =>
product_definition_shape <-
shape_aspect.of_shape
[shape_aspect <-
shape_aspect_relationship.relating_shape_aspect]
[shape_aspect <-
shape_aspect_relationship.related_shape_aspect]
shape_aspect_relationship =>
dimensional_location
dimensional_characteristic = dimensional_location
dimensional_characteristic <-
dimensional_characteristic_representation.dimension
dimensional_characteristic_representation
dimensional_characteristic_representation.representation ->
shape_dimension_representation <=
shape_representation <=)
#2: (piping_component_class <=
characterized_object
characterized_definition = characterized_object
characterized_definition <-
property_definition.definition

```

```

property_definition
represented_definition = property_definition
represented_definition <-
property_definition_representation.definition
property_definition_representation
property_definition_representation.used_representation ->
representation
representation.name = 'flange fitting dimensional shape'}
representation
representation.items[i] ->
representation_item
representation_item.name = 'hole straddle centreline orientation'}
representation_item =>
geometric_representation_item =>
placement =>
axis2_placement_3d

```

### 5.1.9.20 Gasket

#1: The attributes are for the individual piping component.

#2: The attributes are for the definition of a family of piping components.

AIM element:      #1: (piping\_component\_definition)  
                      #2: (piping\_component\_class)

Source:            227

Rules:             dependent\_instantiable\_product\_context  
                      product\_context\_discipline\_type\_constraint  
                      value\_for\_application\_context

Reference path:    #1: (piping\_component\_definition <=  
                      product\_definition  
                      {product\_definition  
                      product\_definition.formation ->  
                      product\_definition\_formation  
                      product\_definition\_formation.of\_product ->  
                      [product  
                      classification\_item = product  
                      classification\_item <-  
                      applied\_classification\_assignment.items[i]  
                      applied\_classification\_assignment <=  
                      classification\_assignment  
                      classification\_assignment.assigned\_classification ->  
                      (group)  
                      (group <-  
                      group\_relationship.related\_group  
                      group\_relationship  
                      group\_relationship.relating\_group ->  
                      group)  
                      group.name = 'gasket']  
                      [product  
                      product.frame\_of\_reference[i] ->

```

product_context<=
application_context_element
application_context_element.name = 'plant item'})
#2: (piping_component_class <=
[characterized_object]
[group])
227

```

### 5.1.9.20.1 compressed\_thickness

#1: The attributes are for the individual piping component.

#2: The attributes are for the definition of a family of piping components.

AIM element: [measure\_with\_unit.value\_component]  
[measure\_with\_unit.unit\_component]

Source: 41

Rules: subtype\_exclusive\_characterized\_object  
subtype\_mandatory\_shape\_representation

Reference path: #1: (piping\_component\_definition <=
product\_definition
characterized\_product\_definition = product\_definition
characterized\_product\_definition
characterized\_definition = characterized\_product\_definition
characterized\_definition <-
property\_definition.definition
property\_definition =>
product\_definition\_shape <-
shape\_aspect.of\_shape
[shape\_aspect <-
shape\_aspect\_relationship.relate\_shape\_aspect]
[shape\_aspect <-
shape\_aspect\_relationship.related\_shape\_aspect]
shape\_aspect\_relationship =>
dimensional\_location
dimensional\_characteristic = dimensional\_location
dimensional\_characteristic <-
dimensional\_characteristic\_representation.dimension
dimensional\_characteristic\_representation
dimensional\_characteristic\_representation.representation ->
shape\_dimension\_representation <=
shape\_representation <=
{representation
representation.name = 'gasket fitting dimensional shape'}
representation
representation.items[i] ->
{representation\_item
representation\_item.name = 'thickness'})
#2: (piping\_component\_class <=
characterized\_object
characterized\_definition = characterized\_object

```

characterized_definition <-
property_definition.definition
property_definition
represented_definition = property_definition
represented_definition <-
property_definition_representation.definition
property_definition_representation
property_definition_representation.used_representation ->
{representation
representation.name = 'gasket fitting class dimensions'}
representation
(representation.items[i] ->
{representation_item
(representation_item.name = 'maximum thickness')
(representation_item.name = 'minimum thickness'}})
([representation.items[i] ->
{representation_item
representation_item.name = 'maximum thickness'}]
[representation.items[i] ->
{representation_item
representation_item.name = 'minimum thickness'}}]))
representation_item =>
{qualified_representation_item
qualified_representation_item.qualifiers[i] ->
value_qualifier
value_qualifier = type_qualifier
type_qualifier
type_qualifier.name = 'compressed'}
measure_representation_item <=
{measure_with_unit =>
length_measure_with_unit}
measure_with_unit
[measure_with_unit.value_component]
[measure_with_unit.unit_component]

```

### 5.1.9.20.2 uncompressed\_thickness

#1: The attributes are for the individual piping component.

#2: The attributes are for the definition of a family of piping components.

AIM element: [measure\_with\_unit.value\_component]  
[measure\_with\_unit.unit\_component]

Source: 41

Rules: subtype\_exclusive\_characterized\_object  
subtype\_mandatory\_shape\_representation

Reference path: #1: (piping\_component\_definition <=  
product\_definition  
characterized\_product\_definition = product\_definition  
characterized\_product\_definition  
characterized\_definition = characterized\_product\_definition

```

characterized_definition <-
property_definition.definition
property_definition =>
product_definition_shape <-
shape_aspect.of_shape
[shape_aspect <-
shape_aspect_relationship.relating_shape_aspect]
[shape_aspect <-
shape_aspect_relationship.related_shape_aspect]
shape_aspect_relationship =>
dimensional_location
dimensional_characteristic = dimensional_location
dimensional_characteristic <-
dimensional_characteristic_representation.dimension
dimensional_characteristic_representation
dimensional_characteristic_representation.representation ->
shape_dimension_representation <=
shape_representation <=
{representation
representation.name = 'gasket fitting dimensional shape'}
representation
representation.items[i] ->
{representation_item
representation_item.name = 'thickness'})
#2: (piping_component_class <=
characterized_object
characterized_definition = characterized_object
characterized_definition <-
property_definition.definition
property_definition
represented_definition = property_definition
represented_definition <-
property_definition_representation.definition
property_definition_representation
property_definition_representation.used_representation ->
{representation
representation.name = 'gasket fitting class dimensions'}
representation
(representation.items[i] ->
{representation_item
(representation_item.name = 'maximum thickness')
(representation_item.name = 'minimum thickness')}}
([representation.items[i] ->
{representation_item
representation_item.name = 'maximum thickness'}}
[representation.items[i] ->
{representation_item
representation_item.name = 'minimum thickness'}}]))
representation_item =>
{qualified_representation_item
qualified_representation_item.qualifiers[i] ->
value_qualifier
value_qualifier = type_qualifier
type_qualifier

```

```

type_qualifier.name = 'uncompressed'}
measure_representation_item <=
{measure_with_unit =>
length_measure_with_unit}
measure_with_unit
[measure_with_unit.value_component]
[measure_with_unit.unit_component]

```

### 5.1.9.21 Gusset

AIM element:	reinforcing_component_definition
Source:	227
Rules:	dependent_instantiable_product_context product_context_discipline_type_constraint value_for_application_context
Reference path:	<pre> reinforcing_component_definition &lt;= product_definition {reinforcing_component_definition classification_item = reinforcing_component_definition classification_item &lt;- applied_classification_assignment.items[i] applied_classification_assignment &lt;= classification_assignment classification_assignment.assigned_classification -&gt; [group =&gt; piping_support_fitting_-class] [group group.name = 'gusset']} {product_definition product_definition.formation -&gt; product_definition_formation product_definition_formation.of_product -&gt; [product classification_item = product classification_item &lt;- applied_classification_assignment.items[i] applied_classification_assignment &lt;= classification_assignment classification_assignment.assigned_classification -&gt; (group) (group &lt;- group_relationship.related_group group_relationship group_relationship.relate_group -&gt; group) group.name = 'reinforcing component'] [product product.frame_of_reference[i] -&gt; product_context &lt;= application_context_element </pre>

```
application_context_element.name = 'plant item']})
```

### 5.1.9.21.1 height

AIM element: [measure\_with\_unit.value\_component]  
[measure\_with\_unit.unit\_component]

Source: 41

Rules: subtype\_mandatory\_shape\_representation

Reference path: reinforcing\_component\_definition <=  
product\_definition  
characterized\_product\_definition = product\_definition  
characterized\_product\_definition  
characterized\_definition = characterized\_product\_definition  
characterized\_definition <=  
property\_definition.definition  
property\_definition =>  
product\_definition\_shape <=  
shape\_aspect.of\_shape  
[shape\_aspect <=  
shape\_aspect\_relationship.relating\_shape\_aspect]  
[shape\_aspect <=  
shape\_aspect\_relationship.related\_shape\_aspect]  
shape\_aspect\_relationship =>  
dimensional\_location  
dimensional\_characteristic = dimensional\_location  
dimensional\_characteristic <=  
dimensional\_characteristic\_representation.dimension  
dimensional\_characteristic\_representation  
dimensional\_characteristic\_representation.representation ->  
shape\_dimension\_representation <=  
shape\_representation <=  
{representation  
representation.name = 'gusset dimensional shape'}  
representation  
representation.items[i] ->  
representation\_item =>  
{representation\_item.name = 'height'}  
measure\_representation\_item <=  
{measure\_with\_unit =>  
length\_measure\_with\_unit}  
measure\_with\_unit  
[measure\_with\_unit.value\_component]  
[measure\_with\_unit.unit\_component]

### 5.1.9.22 Inline\_equipment

AIM element: inline\_equipment

Source: 227

Rules: dependent\_instantiable\_product\_context  
product\_context\_discipline\_type\_constraint  
value\_for\_application\_context

Reference path: inline\_equipment <=  
{piping\_component\_definition  
classification\_item = piping\_component\_definition  
classification\_item <=  
applied\_classification\_assignment.items[i]  
applied\_classification\_assignment <=  
classification\_assignment  
classification\_assignment.assigned\_classification ->  
group  
group.name = 'equipment'}  
piping\_component\_definition <=  
product\_definition  
{product\_definition  
product\_definition.formation ->  
product\_definition\_formation  
product\_definition\_formation.of\_product ->  
product  
product.frame\_of\_reference[i] ->  
product\_context<=  
application\_context\_element  
application\_context\_element.name = 'plant item'}

### 5.1.9.23 Inline\_instrument

AIM element: piping\_component\_definition

Source: 227

Rules: dependent\_instantiable\_product\_context  
product\_context\_discipline\_type\_constraint  
value\_for\_application\_context

Reference path: piping\_component\_definition <=  
product\_definition  
{[piping\_component\_definition  
classification\_item = piping\_component\_definition  
classification\_item <=  
applied\_classification\_assignment.items[i]  
applied\_classification\_assignment <=  
classification\_assignment  
classification\_assignment.assigned\_classification ->  
group  
group.name = 'instrument']  
[piping\_component\_definition <=  
product\_definition  
product\_definition.formation ->  
product\_definition\_formation  
product\_definition\_formation.of\_product ->  
product  
product.frame\_of\_reference[i] ->

```

product_context<=
application_context_element
application_context_element.name = 'plant item']]

```

### 5.1.9.24 Insert

#1: The attributes are for the individual piping component.

#2: The attributes are for the definition of a family of piping components.

AIM element:      #1: (piping\_component\_definition)  
                      #2: (piping\_component\_class)

Source:            227

Rules:             dependent\_instantiable\_product\_context  
                      product\_context\_discipline\_type\_constraint  
                      value\_for\_application\_context

Reference path:    #1: (piping\_component\_definition <=  
                      product\_definition  
                      {product\_definition  
                      product\_definition.formation ->  
                      product\_definition\_formation  
                      product\_definition\_formation.of\_product ->  
                      [product  
                      classification\_item = product  
                      classification\_item <=  
                      applied\_classification\_assignment.items[i]  
                      applied\_classification\_assignment <=  
                      classification\_assignment  
                      classification\_assignment.assigned\_classification ->  
                      (group)  
                      (group <=  
                      group\_relationship.related\_group  
                      group\_relationship  
                      group\_relationship.relating\_group ->  
                      group)  
                      group.name = 'insert']  
                      [product  
                      product.frame\_of\_reference[i] ->  
                      product\_context<=  
                      application\_context\_element  
                      application\_context\_element.name = 'plant item']})  
                      #2: (piping\_component\_class <=  
                      [characterized\_object]  
                      [group])  
                      227

#### 5.1.9.24.1 end\_1\_connector

AIM element:      plant\_item\_connector

Source: 227

Reference path: piping\_component\_definition <=  
product\_definition  
characterized\_product\_definition = product\_definition  
characterized\_product\_definition  
characterized\_definition = characterized\_product\_definition  
characterized\_definition <=  
property\_definition.definition  
property\_definition =>  
product\_definition\_shape <=  
shape\_aspect.of\_shape  
{shape\_aspect  
shape\_aspect.description = 'end 1'}  
shape\_aspect =>  
plant\_item\_connector

### 5.1.9.24.2 end\_2\_connector

AIM element: plant\_item\_connector

Source: 227

Reference path: piping\_component\_definition <=  
product\_definition  
characterized\_product\_definition = product\_definition  
characterized\_product\_definition  
characterized\_definition = characterized\_product\_definition  
characterized\_definition <=  
property\_definition.definition  
property\_definition =>  
product\_definition\_shape <=  
shape\_aspect.of\_shape  
{shape\_aspect  
shape\_aspect.description = 'end 2'}  
shape\_aspect =>  
plant\_item\_connector

### 5.1.9.24.3 end\_to\_end\_length

#1: The attributes are for the individual piping component.

#2: The attributes are for the definition of a family of piping components.

AIM element: [measure\_with\_unit.value\_component]  
[measure\_with\_unit.unit\_component]

Source: 41

Rules: subtype\_exclusive\_characterized\_object  
subtype\_mandatory\_shape\_representation

Reference path: #1: (piping\_component\_definition <=

```

product_definition
characterized_product_definition = product_definition
characterized_product_definition
characterized_definition = characterized_product_definition
characterized_definition <-
property_definition.definition
property_definition =>
product_definition_shape <-
shape_aspect.of_shape
[[[shape_aspect =>
plant_item_connector]
[shape_aspect
shape_aspect.description = 'end 1']]
shape_aspect <-
shape_aspect_relationship.relatng_shape_aspect]
[[[shape_aspect =>
plant_item_connector]
[shape_aspect
shape_aspect.description = 'end 2']]
shape_aspect <-
shape_aspect_relationship.related_shape_aspect]
shape_aspect_relationship =>
dimensional_location
dimensional_characteristic = dimensional_location
dimensional_characteristic <-
dimensional_characteristic_representation.dimension
dimensional_characteristic_representation
dimensional_characteristic_representation.representation ->
shape_dimension_representation <=
shape_representation <=
{representation
representation.name = 'insert fitting dimensional shape'}
representation
representation.items[i] ->
{representation_item
representation_item.name = 'end to end length'}}
#2: (piping_component_class <=
characterized_object
characterized_definition = characterized_object
characterized_definition <-
property_definition.definition
property_definition
represented_definition = property_definition
represented_definition <-
property_definition_representation.definition
property_definition_representation
property_definition_representation.used_representation ->
{representation
representation.name = 'insert fitting class dimensions'}
representation
(representation.items[i] ->
{representation_item
(representation_item.name = 'maximum end to end length')
(representation_item.name = 'minimum end to end length')}}

```

```

([representation.items[i] ->
 {representation_item
 representation_item.name = 'maximum end to end length'}}]
 [representation.items[i] ->
 {representation_item
 representation_item.name = 'minimum end to end length'}}]))
representation_item =>
measure_representation_item <=
 {measure_with_unit =>
 length_measure_with_unit}
measure_with_unit
 [measure_with_unit.value_component]
 [measure_with_unit.unit_component]

```

### 5.1.9.25 Inside\_and\_thickness

#1: The attributes are for the individual piping component.

#2: The attributes are for the definition of a family of piping components.

AIM element: #1: (shape\_dimension\_representation)  
#2: (representation)

Source: 43, 47

Reference path: #1: ({ shape\_dimension\_representation <=  
shape\_representation <=  
[representation  
representation.name = 'piping component dimensions']  
[representation <-  
property\_definition\_representation.used\_representation  
property\_definition\_representation  
property\_definition\_representation.definition ->  
(represented\_definition  
represented\_definition = property\_definition  
{property\_definition =>  
product\_definition\_shape}  
property\_definition  
property\_definition.definition ->  
characterized\_definition  
characterized\_definition = characterized\_product\_definition  
characterized\_product\_definition  
characterized\_product\_definition = product\_definition  
product\_definition =>  
piping\_component\_definition)  
(represented\_definition  
represented\_definition = shape\_aspect  
shape\_aspect =>  
plant\_item\_connector))})#2: ({[representation  
representation.name = 'piping component class size']  
[representation <-  
property\_definition\_representation.used\_representation  
property\_definition\_representation  
property\_definition\_representation.definition ->

```

represented_definition
represented_definition = property_definition
property_definition
property_definition.definition ->
characterized_definition
characterized_definition = characterized_object
characterized_object =>
piping_component_class]])

```

### 5.1.9.25.1 inside\_diameter

#1: The attributes are for the individual piping component.

#2: The attributes are for the definition of a family of piping components.

```

AIM element:    [measure_with_unit.value_component]
                [measure_with_unit.unit_component]

Source:         41

Rules:          subtype_mandatory_shape_representation

Reference path: #1: (shape_dimension_representation <=
                  shape_representation <=
                  representation
                  representation.items[i] ->
                  {representation_item
                   representation_item.name = 'inside diameter'})
                #2: (representation
                    (representation.items[i] ->
                     {representation_item
                      (representation_item.name = 'maximum inside diameter')
                      (representation_item.name = 'minimum inside diameter')}))
                    ([representation.items[i] ->
                     {representation_item
                      representation_item.name = 'maximum inside diameter'}}]
                    [representation.items[i] ->
                     {representation_item
                      representation_item.name = 'minimum inside diameter'}}]))
                    representation_item =>
                    measure_representation_item <=
                    {measure_with_unit =>
                     length_measure_with_unit}
                    measure_with_unit
                    [measure_with_unit.value_component]
                    [measure_with_unit.unit_component]

```

### 5.1.9.25.2 thickness

#1: The attributes are for the individual piping component.

#2: The attributes are for the definition of a family of piping components.

AIM element: [measure\_with\_unit.value\_component]  
[measure\_with\_unit.unit\_component]

Source: 41

Rules: subtype\_mandatory\_shape\_representation

Reference path: #1: (shape\_dimension\_representation <=  
shape\_representation <=  
representation  
representation.items[i] ->  
{representation\_item  
representation\_item.name = 'thickness'})  
#2: (representation  
(representation.items[i] ->  
{representation\_item  
(representation\_item.name = 'maximum thickness')  
(representation\_item.name = 'minimum thickness')})  
([representation.items[i] ->  
{representation\_item  
representation\_item.name = 'maximum thickness'})]  
[representation.items[i] ->  
{representation\_item  
representation\_item.name = 'minimum thickness'}}])  
representation\_item =>  
measure\_representation\_item <=  
{measure\_with\_unit =>  
length\_measure\_with\_unit}  
measure\_with\_unit  
[measure\_with\_unit.value\_component]  
[measure\_with\_unit.unit\_component]

### 5.1.9.26 Lap\_joint\_flange

AIM element: piping\_component\_definition

Source: 227

Rules: dependent\_instantiable\_product\_context  
product\_context\_discipline\_type\_constraint  
value\_for\_application\_context

Reference path: piping\_component\_definition <=  
product\_definition  
{piping\_component\_definition  
classification\_item = piping\_component\_definition  
classification\_item <=  
applied\_classification\_assignment.items[i]  
applied\_classification\_assignment <=  
classification\_assignment  
classification\_assignment.assigned\_classification ->  
[group =>  
flange\_fitting\_neck\_type\_class]  
[group

```

group.name = 'lap joint flange']}
{product_definition
product_definition.formation ->
product_definition_formation
product_definition_formation.of_product ->
[product
classification_item = product
classification_item <-
applied_classification_assignment.items[i]
applied_classification_assignment <=
classification_assignment
classification_assignment.assigned_classification ->
(group)
(group <-
group_relationship.related_group
group_relationship
group_relationship.relate_group ->
group)
group.name = 'flange']
[product
product.frame_of_reference[i] ->
product_context<=
application_context_element
application_context_element.name = 'plant item']]

```

### 5.1.9.27 Lap\_joint\_stub\_end

#1: The attributes are for the individual piping component.

#2: The attributes are for the definition of a family of piping components.

AIM element: #1: (piping\_component\_definition)  
#2: (piping\_component\_class)

Source: 227

Rules: dependent\_instantiable\_product\_context  
product\_context\_discipline\_type\_constraint  
value\_for\_application\_context

Reference path: #1: (piping\_component\_definition <=  
product\_definition  
{product\_definition  
product\_definition.formation ->  
product\_definition\_formation  
product\_definition\_formation.of\_product ->  
[product  
classification\_item = product  
classification\_item <-  
applied\_classification\_assignment.items[i]  
applied\_classification\_assignment <=  
classification\_assignment  
classification\_assignment.assigned\_classification ->  
(group)

```

(group <-
group_relationship.related_group
group_relationship
group_relationship.relatng_group ->
group)
group.name = 'lap joint stub end']
[product
product.frame_of_reference[i] ->
product_context<=
application_context_element
application_context_element.name = 'plant item']})
#2: (piping_component_class <=
[characterized_object]
[group])
227

```

### 5.1.9.27.1 end\_1\_connector

AIM element: plant\_item\_connector

Source: 227

Reference path:

```

piping_component_definition <=
product_definition
characterized_product_definition = product_definition
characterized_product_definition
characterized_definition = characterized_product_definition
characterized_definition <-
property_definition.definition
property_definition =>
product_definition_shape <-
shape_aspect.of_shape
{shape_aspect
shape_aspect.description = 'end 1'}
shape_aspect =>
plant_item_connector

```

### 5.1.9.27.2 end\_2\_connector

AIM element: plant\_item\_connector

Source: 227

Reference path:

```

piping_component_definition <=
product_definition
characterized_product_definition = product_definition
characterized_product_definition
characterized_definition = characterized_product_definition
characterized_definition <-
property_definition.definition
property_definition =>
product_definition_shape <-
shape_aspect.of_shape

```

```

{shape_aspect
shape_aspect.description = 'end 2'}
shape_aspect =>
plant_item_connector

```

### 5.1.9.27.3 length

#1: The attributes are for the individual piping component.

#2: The attributes are for the definition of a family of piping components.

AIM element: [measure\_with\_unit.value\_component]  
[measure\_with\_unit.unit\_component]

Source: 41

Rules: subtype\_exclusive\_characterized\_object  
subtype\_mandatory\_shape\_representation

Reference path: #1: (piping\_component\_definition <=  
product\_definition  
characterized\_product\_definition = product\_definition  
characterized\_product\_definition  
characterized\_definition = characterized\_product\_definition  
characterized\_definition <=  
property\_definition.definition  
property\_definition =>  
product\_definition\_shape <=  
shape\_aspect.of\_shape  
[shape\_aspect <=  
shape\_aspect\_relationship.relate\_shape\_aspect]  
[shape\_aspect <=  
shape\_aspect\_relationship.related\_shape\_aspect]  
shape\_aspect\_relationship =>  
dimensional\_location  
dimensional\_characteristic = dimensional\_location  
dimensional\_characteristic <=  
dimensional\_characteristic\_representation.dimension  
dimensional\_characteristic\_representation  
dimensional\_characteristic\_representation.representation ->  
shape\_dimension\_representation <=  
shape\_representation <=  
{representation  
representation.name = 'lap joint stub end fitting dimensional shape'}  
representation  
representation.items[i] ->  
{representation\_item  
representation\_item.name = 'length'})  
#2: (piping\_component\_class <=  
characterized\_object  
characterized\_definition = characterized\_object  
characterized\_definition <=  
property\_definition.definition  
property\_definition

```

represented_definition = property_definition
represented_definition <-
property_definition_representation.definition
property_definition_representation
property_definition_representation.used_representation ->
{representation
representation.name = 'lap joint stub end fitting class dimensions'}
representation
(representation.items[i] ->
{representation_item
(representation_item.name = 'maximum length')
(representation_item.name = 'minimum length'}})
([representation.items[i] ->
{representation_item
representation_item.name = 'maximum length'}]
[representation.items[i] ->
{representation_item
representation_item.name = 'minimum length'}}]))
representation_item =>
measure_representation_item <=
{measure_with_unit =>
length_measure_with_unit}
measure_with_unit
[measure_with_unit.value_component]
[measure_with_unit.unit_component]

```

#### 5.1.9.27.4 stub\_diameter

#1: The attributes are for the individual piping component.

#2: The attributes are for the definition of a family of piping components.

AIM element: [measure\_with\_unit.value\_component]  
[measure\_with\_unit.unit\_component]

Source: 41

Rules: subtype\_exclusive\_characterized\_object  
subtype\_mandatory\_shape\_representation

Reference path: #1: (piping\_component\_definition <=
product\_definition
characterized\_product\_definition = product\_definition
characterized\_product\_definition
characterized\_definition = characterized\_product\_definition
characterized\_definition <-
property\_definition.definition
property\_definition =>
product\_definition\_shape <-
shape\_aspect.of\_shape
shape\_aspect <-
dimensional\_size.applies\_to
dimensional\_size
dimensional\_characteristic = dimensional\_size

```

dimensional_characteristic <-
dimensional_characteristic_representation.dimension
dimensional_characteristic_representation
dimensional_characteristic_representation.representation ->
shape_dimension_representation <=
shape_representation <=
{representation
representation.name = 'lap joint stub end fitting dimensional shape'}
representation
representation.items[i] ->
{representation_item
representation_item.name = 'stub diameter'}}
#2: (piping_component_class <=
characterized_object
characterized_definition = characterized_object
characterized_definition <-
property_definition.definition
property_definition
represented_definition = property_definition
represented_definition <-
property_definition_representation.definition
property_definition_representation
property_definition_representation.used_representation ->
{representation
representation.name = 'lap joint stub end fitting class dimensions'}
representation
(representation.items[i] ->
{representation_item
(representation_item.name = 'maximum stub diameter')
(representation_item.name = 'minimum stub diameter')}}
([representation.items[i] ->
{representation_item
representation_item.name = 'maximum stub diameter'}}
[representation.items[i] ->
{representation_item
representation_item.name = 'minimum stub diameter'}}]))
representation_item =>
measure_representation_item <=
{measure_with_unit =>
length_measure_with_unit}
measure_with_unit
[measure_with_unit.value_component]
[measure_with_unit.unit_component]

```

### 5.1.9.27.5 stub\_thickness

#1: The attributes are for the individual piping component.

#2: The attributes are for the definition of a family of piping components.

AIM element:       [measure\_with\_unit.value\_component]  
                   [measure\_with\_unit.unit\_component]

Source: 41

Rules: subtype\_exclusive\_characterized\_object  
 subtype\_mandatory\_shape\_representation

Reference path: #1: (piping\_component\_definition <=  
 product\_definition  
 characterized\_product\_definition = product\_definition  
 characterized\_product\_definition  
 characterized\_definition = characterized\_product\_definition  
 characterized\_definition <=  
 property\_definition.definition  
 property\_definition =>  
 product\_definition\_shape <=  
 shape\_aspect.of\_shape  
 [shape\_aspect <=  
 shape\_aspect\_relationship.relate\_shape\_aspect]  
 [shape\_aspect <=  
 shape\_aspect\_relationship.related\_shape\_aspect]  
 shape\_aspect\_relationship =>  
 dimensional\_location  
 dimensional\_characteristic = dimensional\_location  
 dimensional\_characteristic <=  
 dimensional\_characteristic\_representation.dimension  
 dimensional\_characteristic\_representation  
 dimensional\_characteristic\_representation.representation ->  
 shape\_dimension\_representation <=  
 shape\_representation <=  
 {representation  
 representation.name = 'lap joint stub end fitting dimensional shape'}  
 representation  
 representation.items[i] ->  
 {representation\_item  
 representation\_item.name = 'stub thickness'})  
 #2: (piping\_component\_class <=  
 characterized\_object  
 characterized\_definition = characterized\_object  
 characterized\_definition <=  
 property\_definition.definition  
 property\_definition  
 represented\_definition = property\_definition  
 represented\_definition <=  
 property\_definition\_representation.definition  
 property\_definition\_representation  
 property\_definition\_representation.used\_representation ->  
 {representation  
 representation.name = 'lap joint stub end fitting class dimensions'}  
 representation  
 (representation.items[i] ->  
 {representation\_item  
 (representation\_item.name = 'maximum stub thickness')  
 (representation\_item.name = 'minimum stub thickness')})  
 ([representation.items[i] ->  
 {representation\_item

```

representation_item.name = 'maximum stub thickness']]
[representation.items[i] ->
{representation_item
representation_item.name = 'minimum stub thickness'}})])
representation_item =>
measure_representation_item <=
{measure_with_unit =>
length_measure_with_unit}
measure_with_unit
[measure_with_unit.value_component]
[measure_with_unit.unit_component]

```

### 5.1.9.28 Lateral

#1: The attributes are for the individual piping component.

#2: The attributes are for the definition of a family of piping components.

AIM element: #1: (piping\_component\_definition)  
#2: (piping\_component\_class)

Source: 227

Rules: dependent\_instantiable\_product\_context  
product\_context\_discipline\_type\_constraint  
value\_for\_application\_context

Reference path: #1: (piping\_component\_definition <=  
product\_definition  
{product\_definition  
product\_definition.formation ->  
product\_definition\_formation  
product\_definition\_formation.of\_product ->  
[product  
classification\_item = product  
classification\_item <=  
applied\_classification\_assignment.items[i]  
applied\_classification\_assignment <=  
classification\_assignment  
classification\_assignment.assigned\_classification ->  
(group)  
(group <=  
group\_relationship.related\_group  
group\_relationship  
group\_relationship.relying\_group ->  
group)  
group.name = 'lateral']  
[product  
product.frame\_of\_reference[i] ->  
product\_context<=  
application\_context\_element  
application\_context\_element.name = 'plant item']})  
#2: (piping\_component\_class <=  
[characterized\_object]

[group])  
227

### 5.1.9.28.1 **branch\_angle**

#1: The attributes are for the individual piping component.

#2: The attributes are for the definition of a family of piping components.

AIM element: [measure\_with\_unit.value\_component]  
[measure\_with\_unit.unit\_component]

Source: 41

Rules: subtype\_exclusive\_characterized\_object  
subtype\_mandatory\_shape\_representation

Reference path: #1: (piping\_component\_definition <=  
product\_definition  
characterized\_product\_definition = product\_definition  
characterized\_product\_definition  
characterized\_definition = characterized\_product\_definition  
characterized\_definition <=  
property\_definition.definition  
property\_definition =>  
product\_definition\_shape <=  
shape\_aspect.of\_shape  
[shape\_aspect <=  
shape\_aspect\_relationship.relating\_shape\_aspect]  
[shape\_aspect <=  
shape\_aspect\_relationship.related\_shape\_aspect]  
shape\_aspect\_relationship =>  
{dimensional\_location =>  
angular\_location}  
dimensional\_location  
dimensional\_characteristic = dimensional\_location  
dimensional\_characteristic <=  
dimensional\_characteristic\_representation.dimension  
dimensional\_characteristic\_representation  
dimensional\_characteristic\_representation.representation ->  
shape\_dimension\_representation <=  
shape\_representation <=  
{representation  
representation.name = 'lateral fitting dimensional shape'}  
representation  
representation.items[i] ->  
{representation\_item  
representation\_item.name = 'branch angle'})  
#2: (piping\_component\_class <=  
characterized\_object  
characterized\_definition = characterized\_object  
characterized\_definition <=  
property\_definition.definition  
property\_definition

```

represented_definition = property_definition
represented_definition <-
property_definition_representation.definition
property_definition_representation
property_definition_representation.used_representation ->
{representation
representation.name = 'lateral fitting class dimensions'}
representation
(representation.items[i] ->
{representation_item
(representation_item.name = 'maximum branch angle')
(representation_item.name = 'minimum branch angle'}})
([representation.items[i] ->
{representation_item
representation_item.name = 'maximum branch angle'}]
[representation.items[i] ->
{representation_item
representation_item.name = 'minimum branch angle'}}]))
representation_item =>
measure_representation_item <=
{measure_with_unit =>
plane_angle_measure_with_unit}
measure_with_unit
[measure_with_unit.value_component]
[measure_with_unit.unit_component]

```

### 5.1.9.28.2 centre\_to\_end\_1\_length

#1: The attributes are for the individual piping component.

#2: The attributes are for the definition of a family of piping components.

AIM element: [measure\_with\_unit.value\_component]  
[measure\_with\_unit.unit\_component]

Source: 41

Rules: subtype\_exclusive\_characterized\_object  
subtype\_mandatory\_shape\_representation

Reference path: #1: (piping\_component\_definition <=
product\_definition
characterized\_product\_definition = product\_definition
characterized\_product\_definition
characterized\_definition = characterized\_product\_definition
characterized\_definition <-
property\_definition.definition
property\_definition =>
product\_definition\_shape <-
[shape\_aspect.of\_shape
{[shape\_aspect shape\_aspect
shape\_aspect.description = 'centre']}
shape\_aspect <-
shape\_aspect\_relationship.relatng\_shape\_aspect]

```

[shape_aspect.of_shape
{[shape_aspect =>
plant_item_connector]
[shape_aspect
shape_aspect.description = 'end 1']}
shape_aspect <-
shape_aspect_relationship.related_shape_aspect]
shape_aspect_relationship =>
dimensional_location
dimensional_characteristic = dimensional_location
dimensional_characteristic <-
dimensional_characteristic_representation.dimension
dimensional_characteristic_representation
dimensional_characteristic_representation.representation ->
shape_dimension_representation <=
shape_representation <=
{representation
representation.name = 'lateral fitting dimensional shape'}
representation
representation
representation.items[i] ->
{representation_item
representation_item.name = 'centre to end 1 length'})
#2: (piping_component_class <=
characterized_object
characterized_definition = characterized_object
characterized_definition <-
property_definition.definition
property_definition
represented_definition = property_definition
represented_definition <-
property_definition_representation.definition
property_definition_representation
property_definition_representation.used_representation ->
{representation
representation.name = 'lateral fitting class dimensions'}
representation
(representation.items[i] ->
{representation_item
(representation_item.name = 'maximum centre to end 1 length')
(representation_item.name = 'minimum centre to end 1 length'))}
([representation.items[i] ->
{representation_item
representation_item.name = 'maximum centre to end 1 length'}]
[representation.items[i] ->
{representation_item
representation_item.name = 'minimum centre to end 1 length'}}])
representation_item =>
measure_representation_item <=
{measure_with_unit =>
length_measure_with_unit}
measure_with_unit
[measure_with_unit.value_component]

```

[measure\_with\_unit.unit\_component]

### 5.1.9.28.3 centre\_to\_end\_2\_length

#1: The attributes are for the individual piping component.

#2: The attributes are for the definition of a family of piping components.

AIM element: [measure\_with\_unit.value\_component]  
[measure\_with\_unit.unit\_component]

Source: 41

Rules: subtype\_exclusive\_characterized\_object  
subtype\_mandatory\_shape\_representation

Reference path: #1: (piping\_component\_definition <=  
product\_definition  
characterized\_product\_definition = product\_definition  
characterized\_product\_definition  
characterized\_definition = characterized\_product\_definition  
characterized\_definition <=  
property\_definition.definition  
property\_definition =>  
product\_definition\_shape <=  
[shape\_aspect.of\_shape  
{shape\_aspect  
shape\_aspect.description = 'centre'}  
shape\_aspect <=  
shape\_aspect\_relationship.relate\_shape\_aspect]  
[shape\_aspect.of\_shape  
{[shape\_aspect =>  
plant\_item\_connector]  
[shape\_aspect  
shape\_aspect.description = 'end 2']}]  
shape\_aspect <=  
shape\_aspect\_relationship.related\_shape\_aspect]  
shape\_aspect\_relationship =>  
dimensional\_location  
dimensional\_characteristic = dimensional\_location  
dimensional\_characteristic <=  
dimensional\_characteristic\_representation.dimension  
dimensional\_characteristic\_representation  
dimensional\_characteristic\_representation.representation ->  
shape\_dimension\_representation <=  
shape\_representation <=  
{representation  
representation.name = 'lateral fitting dimensional shape'}  
representation  
representation.items[i] ->  
{representation\_item  
representation\_item.name = 'centre to end 2 length'})  
#2: (piping\_component\_class <=  
characterized\_object

```

characterized_definition = characterized_object
characterized_definition <-
property_definition.definition
property_definition
represented_definition = property_definition
represented_definition <-
property_definition_representation.definition
property_definition_representation
property_definition_representation.used_representation ->
{representation
representation.name = 'lateral fitting class dimensions'}
representation
(representation.items[i] ->
{representation_item
(representation_item.name = 'maximum centre to end 2 length')
(representation_item.name = 'minimum centre to end 2 length'}})
([representation.items[i] ->
{representation_item
representation_item.name = 'maximum centre to end 2 length'}}
[representation.items[i] ->
{representation_item
representation_item.name = 'minimum centre to end 2 length'}}]))
representation_item =>
measure_representation_item <=
{measure_with_unit =>
length_measure_with_unit}
measure_with_unit
[measure_with_unit.value_component]
[measure_with_unit.unit_component]

```

#### 5.1.9.28.4 centre\_to\_end\_3\_length

#1: The attributes are for the individual piping component.

#2: The attributes are for the definition of a family of piping components.

AIM element: [measure\_with\_unit.value\_component]  
[measure\_with\_unit.unit\_component]

Source: 41

Rules: subtype\_exclusive\_characterized\_object  
subtype\_mandatory\_shape\_representation

Reference path: #1: (piping\_component\_definition <=  
product\_definition  
characterized\_product\_definition = product\_definition  
characterized\_product\_definition  
characterized\_definition = characterized\_product\_definition  
characterized\_definition <-  
property\_definition.definition  
property\_definition =>  
product\_definition\_shape <-  
[shape\_aspect.of\_shape

```

{shape_aspect
shape_aspect.description = 'centre'}
shape_aspect <-
shape_aspect_relationship.relate_shape_aspect]
[shape_aspect.of_shape
{[shape_aspect =>
plant_item_connector]
[shape_aspect
shape_aspect.description = 'end 3']}
shape_aspect <-
shape_aspect_relationship.related_shape_aspect]
shape_aspect_relationship =>
dimensional_location
dimensional_characteristic = dimensional_location
dimensional_characteristic <-
dimensional_characteristic_representation.dimension
dimensional_characteristic_representation
dimensional_characteristic_representation.representation ->
shape_dimension_representation <=
shape_representation <=
{representation
representation.name = 'lateral fitting dimensional shape'}
representation
representation.items[i] ->
{representation_item
representation_item.name = 'centre to end 3 length'}}
#2: (piping_component_class <=
characterized_object
characterized_definition = characterized_object
characterized_definition <-
property_definition.definition
property_definition
represented_definition = property_definition
represented_definition <-
property_definition_representation.definition
property_definition_representation
property_definition_representation.used_representation ->
{representation
representation.name = 'lateral fitting class dimensions'}
representation
(representation.items[i] ->
{representation_item
(representation_item.name = 'maximum centre to end 3 length')
(representation_item.name = 'minimum centre to end 3 length'}})
([representation.items[i] ->
{representation_item
representation_item.name = 'maximum centre to end 3 length'}}
[representation.items[i] ->
{representation_item
representation_item.name = 'minimum centre to end 3 length'}})])
representation_item =>
measure_representation_item <=
{measure_with_unit =>
length_measure_with_unit}

```

```

measure_with_unit
[measure_with_unit.value_component]
[measure_with_unit.unit_component]

```

### 5.1.9.28.5 end\_1\_connector

AIM element: plant\_item\_connector

Source: 227

Reference path:

```

piping_component_definition <=
product_definition
characterized_product_definition = product_definition
characterized_product_definition
characterized_definition = characterized_product_definition
characterized_definition <-
property_definition.definition
property_definition =>
product_definition_shape <-
shape_aspect.of_shape
{shape_aspect
shape_aspect.description = 'end 1'}
shape_aspect =>
plant_item_connector

```

### 5.1.9.28.6 end\_2\_connector

AIM element: plant\_item\_connector

Source: 227

Reference path:

```

piping_component_definition <=
product_definition
characterized_product_definition = product_definition
characterized_product_definition
characterized_definition = characterized_product_definition
characterized_definition <-
property_definition.definition
property_definition =>
product_definition_shape <-
shape_aspect.of_shape
{shape_aspect
shape_aspect.description = 'end 2'}
shape_aspect =>
plant_item_connector

```

### 5.1.9.28.7 end\_3\_connector

AIM element: plant\_item\_connector

Source: 227

Reference path:   piping\_component\_definition <=  
                   product\_definition  
                   characterized\_product\_definition = product\_definition  
                   characterized\_product\_definition  
                   characterized\_definition = characterized\_product\_definition  
                   characterized\_definition <=  
                   property\_definition.definition  
                   property\_definition =>  
                   product\_definition\_shape <=  
                   shape\_aspect.of\_shape  
                   { shape\_aspect  
                   shape\_aspect.description = 'end 3' }  
                   shape\_aspect =>  
                   plant\_item\_connector

### 5.1.9.29   Lined\_piping

AIM element:       piping\_spool\_definition

Source:            227

Reference path:   piping\_spool\_definition <=  
                   product\_definition  
                   classification\_item = product\_definition  
                   classification\_item <=  
                   applied\_classification\_assignment.items[i]  
                   applied\_classification\_assignment <=  
                   { classification\_assignment  
                   classification\_assignment.role ->  
                   group\_role  
                     
                   group\_role.name = 'lining type' }  
                   classification\_assignment  
                   classification\_assignment.assigned\_classification ->  
                   group  
                   group.name  
                   { group.name = 'lined' }

#### 5.1.9.29.1   lining\_thickness\_inside\_pipe

AIM element:       [measure\_with\_unit.value\_component]  
                   [measure\_with\_unit.unit\_component]

Source:            41

Reference path:   piping\_spool\_definition <=  
                   product\_definition <=  
                   characterized\_product\_definition = product\_definition  
                   characterized\_definition = characterized\_product\_definition  
                   characterized\_definition <=  
                   property\_definition.definition  
                   property\_definition =>  
                   product\_definition\_shape <=

```

shape_aspect.of_shape
{ shape_aspect
shape_aspect.name = 'pipe lining'}
shape_aspect
represented_definition = shape_aspect
represented_definition <-
property_definition_representation.definition
{property_definition_representation =>
shape_definition_representation}
property_definition_representation
property_definition_representation.used_representation ->
representation
representation.items [i] ->
{representation_item
representation_item.name = 'thickness'}
representation_item =>
measure_representation_item <=
{measure_with_unit =>
length_measure_with_unit}
measure_with_unit
[measure_with_unit.value_component]
[measure_with_unit.unit_component]

```

#### 5.1.9.29.2 lining\_thickness\_at\_flange\_face

AIM element: [measure\_with\_unit.value\_component]  
[measure\_with\_unit.unit\_component]

Source: 41

Reference path:

```

piping_spool_definition <=
product_definition <-
characterized_product_definition = product_definition
characterized_definition = characterized_product_definition
characterized_definition <-
property_definition.definition
property_definition =>
product_definition_shape <-
shape_aspect.of_shape
{ shape_aspect
shape_aspect.name = 'flange face lining'}
shape_aspect
represented_definition = shape_aspect
represented_definition <-
property_definition_representation.definition
{property_definition_representation =>
shape_definition_representation}
property_definition_representation
property_definition_representation.used_representation ->
representation
representation.items [i] ->
{representation_item
representation_item.name = 'thickness'}
representation_item =>

```

```

measure_representation_item <=
{ measure_with_unit =>
length_measure_with_unit }
measure_with_unit
[measure_with_unit.value_component]
[measure_with_unit.unit_component]

```

### 5.1.9.30 Lug

AIM element: piping\_support\_definition

Source: 227

Rules: dependent\_instantiable\_product\_context  
product\_context\_discipline\_type\_constraint  
value\_for\_application\_context

Reference path: piping\_support\_definition <=

```

product_definition
{ piping_support_definition
classification_item = piping_support_definition
classification_item <-
applied_classification_assignment.items[i]
applied_classification_assignment <=
classification_assignment
classification_assignment.assigned_classification ->
[group =>
piping_support_fitting_-class]
[group
group.name = 'lug']]
{ product_definition
product_definition.formation ->
product_definition_formation
product_definition_formation.of_product ->
[product
classification_item = product
classification_item <-
applied_classification_assignment.items[i]
applied_classification_assignment <=
classification_assignment
classification_assignment.assigned_classification ->
(group)
(group <-
group_relationship.related_group
group_relationship
group_relationship.relating_group ->
group)
group.name = 'piping support']
[product
product.frame_of_reference[i] ->
product_context <=
application_context_element
application_context_element.name = 'plant item']]

```

**5.1.9.30.1 length**

AIM element: [measure\_with\_unit.value\_component]  
[measure\_with\_unit.unit\_component]

Source: 41

Rules: subtype\_mandatory\_shape\_representation

Reference path: piping\_support\_definition <=  
product\_definition  
characterized\_product\_definition = product\_definition  
characterized\_product\_definition  
characterized\_definition = characterized\_product\_definition  
characterized\_definition <=  
property\_definition.definition  
property\_definition =>  
product\_definition\_shape <=  
shape\_aspect.of\_shape  
[shape\_aspect <=  
shape\_aspect\_relationship.relate\_shape\_aspect]  
[shape\_aspect <=  
shape\_aspect\_relationship.related\_shape\_aspect]  
shape\_aspect\_relationship =>  
dimensional\_location  
dimensional\_characteristic = dimensional\_location  
dimensional\_characteristic <=  
dimensional\_characteristic\_representation.dimension  
dimensional\_characteristic\_representation  
dimensional\_characteristic\_representation.representation ->  
shape\_dimension\_representation <=  
shape\_representation <=  
{representation  
representation.name = 'lug dimensional shape'}  
representation  
representation.items[i] ->  
representation\_item =>  
{representation\_item.name = 'length'}  
measure\_representation\_item <=  
{measure\_with\_unit =>  
length\_measure\_with\_unit}  
measure\_with\_unit  
[measure\_with\_unit.value\_component]  
[measure\_with\_unit.unit\_component]

**5.1.9.31 Mitre\_bend\_pipe**

#1: The attributes are for the individual piping component.

#2: The attributes are for the definition of a family of piping components.

AIM element: #1: (piping\_component\_definition)  
#2: (piping\_component\_class)

Source: 227

Rules: dependent\_instantiable\_product\_context  
product\_context\_discipline\_type\_constraint  
value\_for\_application\_context

Reference path: #1: (piping\_component\_definition <=  
product\_definition  
{piping\_component\_definition  
classification\_item = piping\_component\_definition  
classification\_item <=  
applied\_classification\_assignment.items[i]  
applied\_classification\_assignment <=  
classification\_assignment  
classification\_assignment.assigned\_classification ->  
[group =>  
pipe\_class]  
[group  
group.name = 'mitre bend pipe']}  
{product\_definition  
product\_definition.formation ->  
product\_definition\_formation  
product\_definition\_formation.of\_product ->  
[product  
classification\_item = product  
classification\_item <=  
applied\_classification\_assignment.items[i]  
applied\_classification\_assignment <=  
classification\_assignment  
classification\_assignment.assigned\_classification ->  
(group)  
(group <=  
group\_relationship.related\_group  
group\_relationship  
group\_relationship.relating\_group ->  
group)  
group.name = 'pipe']  
227  
[product  
product.frame\_of\_reference[i] ->  
product\_context<=  
application\_context\_element  
application\_context\_element.name = 'plant item']})  
#2: (piping\_component\_class <=  
[characterized\_object]  
[group])

### 5.1.9.31.1 number\_of\_segments

#1: The attributes are for the individual piping component.

#2: The attributes are for the definition of a family of piping components.

AIM element: [measure\_with\_unit.value\_component]  
[measure\_with\_unit.unit\_component]

Source: 41

Rules: subtype\_exclusive\_characterized\_object

Reference path: #1: (piping\_component\_definition <=  
product\_definition  
characterized\_product\_definition = product\_definition  
characterized\_product\_definition  
characterized\_definition = characterized\_product\_definition  
characterized\_definition <=  
property\_definition.definition  
property\_definition  
represented\_definition = property\_definition  
represented\_definition <=  
property\_definition\_representation.definition  
property\_definition\_representation  
property\_definition\_representation.used\_representation ->  
{representation  
representation.name = 'pipe characteristics'}  
representation  
{representation\_item  
representation\_item.name = 'number of segments'})  
#2: (piping\_component\_class <=  
characterized\_object  
characterized\_definition = characterized\_object  
characterized\_definition <=  
property\_definition.definition  
property\_definition  
represented\_definition = property\_definition  
represented\_definition <=  
property\_definition\_representation.definition  
property\_definition\_representation  
property\_definition\_representation.used\_representation ->  
{representation  
representation.name = 'pipe class characteristics'}  
representation  
(representation.items[i] ->  
{representation\_item  
(representation\_item.name = 'maximum number of segments')  
(representation\_item.name = 'minimum number of segments'}})  
([representation.items[i] ->  
{representation\_item  
representation\_item.name = 'maximum number of segments'}}]  
[representation.items[i] ->  
{representation\_item  
representation\_item.name = 'minimum number of segments'}}]))  
representation\_item =>  
measure\_representation\_item <=  
measure\_with\_unit  
[measure\_with\_unit.value\_component  
{measure\_with\_unit.value\_component ->

```

measure_value
measure_value = count_measure}}
[measure_with_unit.unit_component]

```

### 5.1.9.31.2 radius

#1: The attributes are for the individual piping component.

#2: The attributes are for the definition of a family of piping components.

AIM element: [measure\_with\_unit.value\_component]  
[measure\_with\_unit.unit\_component]

Source: 41

Rules: subtype\_exclusive\_characterized\_object  
subtype\_mandatory\_shape\_representation

Reference path: #1: (piping\_component\_definition <=  
product\_definition  
characterized\_product\_definition = product\_definition  
characterized\_product\_definition  
characterized\_definition = characterized\_product\_definition  
characterized\_definition <=  
property\_definition.definition  
property\_definition =>  
product\_definition\_shape <=  
shape\_aspect.of\_shape  
shape\_aspect <=  
dimensional\_size.applies\_to  
dimensional\_size  
dimensional\_characteristic = dimensional\_size  
dimensional\_characteristic <=  
dimensional\_characteristic\_representation.dimension  
dimensional\_characteristic\_representation  
dimensional\_characteristic\_representation.representation ->  
shape\_dimension\_representation <=  
shape\_representation <=  
{representation  
representation.name = 'pipe dimensional shape'}  
representation  
representation.items[i] ->  
{representation\_item  
representation\_item.name = 'radius'})  
#2: (piping\_component\_class <=  
characterized\_object  
characterized\_definition = characterized\_object  
characterized\_definition <=  
property\_definition.definition  
property\_definition  
represented\_definition = property\_definition  
represented\_definition <=  
property\_definition\_representation.definition  
property\_definition\_representation

```

property_definition_representation.used_representation ->
{representation
representation.name = 'pipe class dimensions'}
representation
(representation.items[i] ->
{representation_item
(representation_item.name = 'maximum radius')
(representation_item.name = 'minimum radius'}})
([representation.items[i] ->
{representation_item
representation_item.name = 'maximum radius'}}]
[representation.items[i] ->
{representation_item
representation_item.name = 'minimum radius'}}]))
representation_item =>
measure_representation_item <=
{measure_with_unit =>
length_measure_with_unit}
measure_with_unit
[measure_with_unit.value_component]
[measure_with_unit.unit_component]

```

### 5.1.9.31.3 sweep\_angle

#1: The attributes are for the individual piping component.

#2: The attributes are for the definition of a family of piping components.

AIM element: [measure\_with\_unit.value\_component]  
[measure\_with\_unit.unit\_component]

Source: 41

Rules: subtype\_exclusive\_characterized\_object  
subtype\_mandatory\_shape\_representation

Reference path: #1: (piping\_component\_definition <=  
product\_definition  
characterized\_product\_definition = product\_definition  
characterized\_product\_definition  
characterized\_definition = characterized\_product\_definition  
characterized\_definition <-  
property\_definition.definition  
property\_definition =>  
product\_definition\_shape <-  
shape\_aspect.of\_shape  
[shape\_aspect <-  
shape\_aspect\_relationship.relate\_shape\_aspect]  
[shape\_aspect <-  
shape\_aspect\_relationship.related\_shape\_aspect]  
shape\_aspect\_relationship =>  
{dimensional\_location =>  
angular\_location}  
dimensional\_location

```

dimensional_characteristic = dimensional_location
dimensional_characteristic <-
dimensional_characteristic_representation.dimension
dimensional_characteristic_representation
dimensional_characteristic_representation.representation ->
shape_dimension_representation <=
shape_representation <=
{representation
representation.name = 'pipe dimensional shape'}
representation
representation.items[i] ->
{representation_item
representation_item.name = 'sweep angle'})
#2: (piping_component_class <=
characterized_object
characterized_definition = characterized_object
characterized_definition <-
property_definition.definition
property_definition
represented_definition = property_definition
represented_definition <-
property_definition_representation.definition
property_definition_representation
property_definition_representation.used_representation ->
{representation
representation.name = 'pipe class dimensions'}
representation
(representation.items[i] ->
{representation_item
(representation_item.name = 'maximum sweep angle')
(representation_item.name = 'minimum sweep angle'))}
([representation.items[i] ->
{representation_item
representation_item.name = 'maximum sweep angle'}}
[representation.items[i] ->
{representation_item
representation_item.name = 'minimum sweep angle'}}]))
representation_item =>
measure_representation_item <=
{measure_with_unit =>
plane_angle_measure_with_unit}
measure_with_unit
[measure_with_unit.value_component]
[measure_with_unit.unit_component]

```

### 5.1.9.32 Nipple

AIM element:       piping\_component\_definition

Source:            227

Rules:             dependent\_instantiable\_product\_context  
                     product\_context\_discipline\_type\_constraint  
                     value\_for\_application\_context

Reference path:     piping\_component\_definition <=  
                           product\_definition  
                           {piping\_component\_definition  
                           classification\_item = piping\_component\_definition  
                           classification\_item <=  
                           applied\_classification\_assignment.items[i]  
                           applied\_classification\_assignment <=  
                           classification\_assignment  
                           classification\_assignment.assigned\_classification ->  
                           [group =>  
                           pipe\_class]  
                           [group  
                           group.name = 'nipple']}  
                           {product\_definition  
                           product\_definition.formation ->  
                           product\_definition\_formation  
                           product\_definition\_formation.of\_product ->  
                           [product  
                           classification\_item = product  
                           classification\_item <=  
                           applied\_classification\_assignment.items[i]  
                           applied\_classification\_assignment <=  
                           classification\_assignment  
                           classification\_assignment.assigned\_classification ->  
                           (group)  
                           (group <=  
                           group\_relationship.related\_group  
                           group\_relationship  
                           group\_relationship.relate\_group ->  
                           group)  
                           group.name = 'pipe']  
                           [product  
                           product.frame\_of\_reference[i] ->  
                           product\_context<=  
                           application\_context\_element  
                           application\_context\_element.name = 'plant item']]

### 5.1.9.32.1     end\_to\_end\_length

AIM element:       [measure\_with\_unit.value\_component]  
                       [measure\_with\_unit.unit\_component]

Source:            41

Reference path:     piping\_component\_definition <=  
                           product\_definition  
                           characterized\_product\_definition = product\_definition  
                           characterized\_product\_definition  
                           characterized\_definition = characterized\_product\_definition  
                           characterized\_definition <=  
                           property\_definition.definition  
                           property\_definition =>  
                           product\_definition\_shape <=

```

shape_aspect.of_shape
[{{[shape_aspect =>
plant_item_connector]
[shape_aspect
shape_aspect.description = 'end 1']}}
shape_aspect <-
shape_aspect_relationship.relate_shape_aspect]
[{{[shape_aspect =>
plant_item_connector]
[shape_aspect
shape_aspect.description = 'end 2']}}
shape_aspect <-
shape_aspect_relationship.related_shape_aspect]
shape_aspect_relationship =>
dimensional_location
dimensional_characteristic = dimensional_location
dimensional_characteristic <-
dimensional_characteristic_representation.dimensional
dimensional_characteristic_representation
dimensional_characteristic_representation.representation ->
shape_dimension_representation <=
shape_representation <=
{representation
representation.name = 'nipple dimensional shape'}
representation
representation.items[i] ->
{representation_item
representation_item.name = 'end to end length'}
representation_item =>
measure_representation_item <=
{measure_with_unit =>
length_measure_with_unit}
measure_with_unit
[measure_with_unit.value_component]
[measure_with_unit.unit_component]

```

### 5.1.9.33 Olet

#1: The attributes are for the individual piping component.

#2: The attributes are for the definition of a family of piping components.

AIM element: #1: (piping\_component\_definition)  
#2: (piping\_component\_class)

Source: 227

Rules: dependent\_instantiable\_product\_context  
product\_context\_discipline\_type\_constraint  
value\_for\_application\_context

Reference path: #1: (piping\_component\_definition <=  
product\_definition  
{product\_definition

```

product_definition.formation ->
product_definition_formation
product_definition_formation.of_product ->
[product
classification_item = product
classification_item <-
applied_classification_assignment.items[i]
applied_classification_assignment <=
classification_assignment
classification_assignment.assigned_classification ->
(group)
(group <-
group_relationship.related_group
group_relationship
group_relationship.relatng_group ->
group)
group.name = 'olet']
[product
product.frame_of_reference[i] ->
product_context<=
application_context_element
application_context_element.name = 'plant item']]
#2: (piping_component_class <=
[characterized_object]
[group])

```

### 5.1.9.33.1 base\_outside\_diameter

#1: The attributes are for the individual piping component.

#2: The attributes are for the definition of a family of piping components.

AIM element: [measure\_with\_unit.value\_component]  
[measure\_with\_unit.unit\_component]

Source: 41

Rules: subtype\_exclusive\_characterized\_object  
subtype\_mandatory\_shape\_representation

Reference path: #1: (piping\_component\_definition <=  
product\_definition  
characterized\_product\_definition = product\_definition  
characterized\_product\_definition  
characterized\_definition = characterized\_product\_definition  
characterized\_definition <-  
property\_definition.definition  
property\_definition =>  
product\_definition\_shape <-  
shape\_aspect.of\_shape  
shape\_aspect <-  
dimensional\_size.applies\_to  
dimensional\_size  
dimensional\_characteristic = dimensional\_size

```

dimensional_characteristic <-
dimensional_characteristic_representation.dimension
dimensional_characteristic_representation
dimensional_characteristic_representation.representation ->
shape_dimension_representation <=
shape_representation <=
{representation
representation.name = 'olet fitting dimensional shape'}
representation
representation.items[i] ->
{representation_item
representation_item.name = 'base outside diameter'}}
#2: (piping_component_class <=
characterized_object
characterized_definition = characterized_object
characterized_definition <-
property_definition.definition
property_definition
represented_definition = property_definition
represented_definition <-
property_definition_representation.definition
property_definition_representation
property_definition_representation.used_representation ->
{representation
representation.name = 'olet fitting class dimensions'}
representation
(representation.items[i] ->
{representation_item
(representation_item.name = 'maximum base outside diameter')
(representation_item.name = 'minimum base outside diameter'}})
([representation.items[i] ->
{representation_item
representation_item.name = 'maximum base outside diameter'}}
[representation.items[i] ->
{representation_item
representation_item.name = 'minimum base outside diameter'}})])
representation_item =>
measure_representation_item <=
{measure_with_unit =>
length_measure_with_unit}
measure_with_unit
[measure_with_unit.value_component]
[measure_with_unit.unit_component]

```

### 5.1.9.33.2 branch\_angle

#1: The attributes are for the individual piping component.

#2: The attributes are for the definition of a family of piping components.

AIM element:       [measure\_with\_unit.value\_component]  
                   [measure\_with\_unit.unit\_component]

Source: 41

Rules: subtype\_exclusive\_characterized\_object  
 subtype\_mandatory\_shape\_representation

Reference path: #1: (piping\_component\_definition <=  
 product\_definition  
 characterized\_product\_definition = product\_definition  
 characterized\_product\_definition  
 characterized\_definition = characterized\_product\_definition  
 characterized\_definition <=  
 property\_definition.definition  
 property\_definition =>  
 product\_definition\_shape <=  
 shape\_aspect.of\_shape  
 [shape\_aspect <=  
 shape\_aspect\_relationship.relate\_shape\_aspect]  
 [shape\_aspect <=  
 shape\_aspect\_relationship.related\_shape\_aspect]  
 shape\_aspect\_relationship =>  
 {dimensional\_location =>  
 angular\_location}  
 dimensional\_location  
 dimensional\_characteristic = dimensional\_location  
 dimensional\_characteristic <=  
 dimensional\_characteristic\_representation.dimension  
 dimensional\_characteristic\_representation  
 dimensional\_characteristic\_representation.representation ->  
 shape\_dimension\_representation <=  
 shape\_representation <=  
 {representation  
 representation.name = 'olet fitting dimensional shape'}  
 representation  
 representation.items[i] ->  
 {representation\_item  
 representation\_item.name = 'branch angle'})  
 #2: (piping\_component\_class <=  
 characterized\_object  
 characterized\_definition = characterized\_object  
 characterized\_definition <=  
 property\_definition.definition  
 property\_definition  
 represented\_definition = property\_definition  
 represented\_definition <=  
 property\_definition\_representation.definition  
 property\_definition\_representation  
 property\_definition\_representation.used\_representation ->  
 {representation  
 representation.name = 'lateral fitting class dimensions'}  
 representation  
 (representation.items[i] ->  
 {representation\_item  
 (representation\_item.name = 'maximum branch angle')  
 (representation\_item.name = 'minimum branch angle'))})

```

([representation.items[i] ->
 {representation_item
 representation_item.name = 'maximum branch angle'}]
 [representation.items[i] ->
 {representation_item
 representation_item.name = 'minimum branch angle'}}))
representation_item =>
measure_representation_item <=
 {measure_with_unit =>
 plane_angle_measure_with_unit}
measure_with_unit
 [measure_with_unit.value_component]
 [measure_with_unit.unit_component]

```

### 5.1.9.33.3 end\_1\_connector

AIM element: plant\_item\_connector

Source: 227

Reference path:

```

piping_component_definition <=
product_definition
characterized_product_definition = product_definition
characterized_product_definition
characterized_definition = characterized_product_definition
characterized_definition <-
property_definition.definition
property_definition =>
product_definition_shape <-
shape_aspect.of_shape
 {shape_aspect
 shape_aspect.description = 'end 1'}
shape_aspect =>
plant_item_connector

```

### 5.1.9.33.4 end\_2\_connector

AIM element: plant\_item\_connector

Source: 227

Reference path:

```

piping_component_definition <=
product_definition
characterized_product_definition = product_definition
characterized_product_definition
characterized_definition = characterized_product_definition
characterized_definition <-
property_definition.definition
property_definition =>
product_definition_shape <-
shape_aspect.of_shape
 {shape_aspect
 shape_aspect.description = 'end 2'}

```

```

shape_aspect =>
plant_item_connector

```

### 5.1.9.33.5 length

#1: The attributes are for the individual piping component.

#2: The attributes are for the definition of a family of piping components.

AIM element: [measure\_with\_unit.value\_component]  
[measure\_with\_unit.unit\_component]

Source: 41

Rules: subtype\_exclusive\_characterized\_object  
subtype\_mandatory\_shape\_representation

Reference path: #1: (piping\_component\_definition <=  
product\_definition  
characterized\_product\_definition = product\_definition  
characterized\_product\_definition  
characterized\_definition = characterized\_product\_definition  
characterized\_definition <=  
property\_definition.definition  
property\_definition =>  
product\_definition\_shape <=  
shape\_aspect.of\_shape  
[shape\_aspect <=  
shape\_aspect\_relationship.relate\_shape\_aspect]  
[shape\_aspect <=  
shape\_aspect\_relationship.related\_shape\_aspect]  
shape\_aspect\_relationship =>  
dimensional\_location  
dimensional\_characteristic = dimensional\_location  
dimensional\_characteristic <=  
dimensional\_characteristic\_representation.dimension  
dimensional\_characteristic\_representation  
dimensional\_characteristic\_representation.representation ->  
shape\_dimension\_representation <=  
shape\_representation <=  
{representation  
representation.name = 'olet fitting dimensional shape'}  
representation  
representation.items[i] ->  
{representation\_item  
representation\_item.name = 'length'})  
#2: (piping\_component\_class <=  
characterized\_object  
characterized\_definition = characterized\_object  
characterized\_definition <=  
property\_definition.definition  
property\_definition  
represented\_definition = property\_definition  
represented\_definition <=

```

property_definition_representation.definition
property_definition_representation
property_definition_representation.used_representation ->
{representation
representation.name = 'olet fitting class dimensions'}
representation
(representation.items[i] ->
{representation_item
(representation_item.name = 'maximum length')
(representation_item.name = 'minimum length'}})
([representation.items[i] ->
{representation_item
representation_item.name = 'maximum length'}}]
[representation.items[i] ->
{representation_item
representation_item.name = 'minimum length'}}]))
representation_item =>
measure_representation_item <=
{measure_with_unit =>
length_measure_with_unit}
measure_with_unit
[measure_with_unit.value_component]
[measure_with_unit.unit_component]

```

#### 5.1.9.33.6 skirt\_outside\_diameter

#1: The attributes are for the individual piping component.

#2: The attributes are for the definition of a family of piping components.

AIM element: [measure\_with\_unit.value\_component]  
[measure\_with\_unit.unit\_component]

Source: 41

Rules: subtype\_exclusive\_characterized\_object  
subtype\_mandatory\_shape\_representation

Reference path: #1: (piping\_component\_definition <=  
product\_definition  
characterized\_product\_definition = product\_definition  
characterized\_product\_definition  
characterized\_definition = characterized\_product\_definition  
characterized\_definition <=  
property\_definition.definition  
property\_definition =>  
product\_definition\_shape <=  
shape\_aspect.of\_shape  
shape\_aspect <=  
dimensional\_size.applies\_to  
dimensional\_size  
dimensional\_characteristic = dimensional\_size  
dimensional\_characteristic <=  
dimensional\_characteristic\_representation.dimension

```

dimensional_characteristic_representation
dimensional_characteristic_representation.representation ->
shape_dimension_representation <=
shape_representation <=
{representation
representation.name = 'olet fitting dimensional shape'}
representation
representation.items[i] ->
{representation_item
representation_item.name = 'skirt outside diameter'}}
#2: (piping_component_class <=
characterized_object
characterized_definition = characterized_object
characterized_definition <-
property_definition.definition
property_definition
represented_definition = property_definition
represented_definition <-
property_definition_representation.definition
property_definition_representation
property_definition_representation.used_representation ->
{representation
representation.name = 'olet fitting class dimensions'}
representation
(representation.items[i] ->
{representation_item
(representation_item.name = 'maximum skirt outside diameter')
(representation_item.name = 'minimum skirt outside diameter'}})
([representation.items[i] ->
{representation_item
representation_item.name = 'maximum skirt outside diameter'}}]
[representation.items[i] ->
{representation_item
representation_item.name = 'minimum skirt outside diameter'}}]))
representation_item =>
measure_representation_item <=
{measure_with_unit =>
length_measure_with_unit}
measure_with_unit
[measure_with_unit.value_component]
[measure_with_unit.unit_component]

```

### 5.1.9.34 Orifice\_flange

AIM element: piping\_component\_definition

Source: 227

Rules: dependent\_instantiable\_product\_context  
product\_context\_discipline\_type\_constraint  
value\_for\_application\_context

Reference path: piping\_component\_definition <=  
product\_definition

```

{piping_component_definition
classification_item = piping_component_definition
classification_item <-
applied_classification_assignment.items[i]
applied_classification_assignment <=
classification_assignment
classification_assignment.assigned_classification ->
[group =>
flange_fitting_class]
[group
group.name = 'orifice flange']]
{product_definition
product_definition.formation ->
product_definition_formation
product_definition_formation.of_product ->
[product
classification_item = product
classification_item <-
applied_classification_assignment.items[i]
applied_classification_assignment <=
classification_assignment
classification_assignment.assigned_classification ->
(group)
(group <-
group_relationship.related_group
group_relationship
group_relationship.relate_group ->
group)
group.name = 'flange']
[product
product.frame_of_reference[i] ->
product_context<=
application_context_element
application_context_element.name = 'plant item']]

```

#### 5.1.9.34.1 jacking\_screw\_orientation

AIM element: shape\_aspect.description

Source: 41

Reference path: piping\_component\_definition <=

```

product_definition
characterized_product_definition = product_definition
characterized_product_definition
characterized_definition = characterized_product_definition
characterized_definition <-
property_definition.definition
property_definition =>
product_definition_shape <-
shape_aspect.of_shape
{shape_aspect
shape_aspect.name = 'jacking screw'}

```

shape\_aspect  
 shape\_aspect.description

### 5.1.9.34.2 tap

AIM element: plant\_item\_connector

Source: 227

Reference path: piping\_component\_definition <=  
 product\_definition  
 characterized\_product\_definition = product\_definition  
 characterized\_product\_definition  
 characterized\_definition = characterized\_product\_definition  
 characterized\_definition <=  
 property\_definition.definition  
 property\_definition =>  
 product\_definition\_shape <=  
 shape\_aspect.of\_shape  
 {shape\_aspect  
 shape\_aspect.description = 'tap'}  
 shape\_aspect =>  
 plant\_item\_connector

### 5.1.9.34.3 tap\_centreline\_orientation

AIM element: axis2\_placement\_3d

Source: 42

Reference path: piping\_component\_definition <=  
 product\_definition  
 characterized\_product\_definition = product\_definition  
 characterized\_product\_definition  
 characterized\_definition = characterized\_product\_definition  
 characterized\_definition <=  
 property\_definition.definition  
 property\_definition =>  
 product\_definition\_shape <=  
 shape\_aspect.of\_shape  
 {[shape\_aspect  
 shape\_aspect.description = 'tap']  
 [shape\_aspect =>  
 plant\_item\_connector]  
 shape\_aspect  
 represented\_definition = shape\_aspect  
 represented\_definition <=  
 property\_definition\_representation.definition  
 {property\_definition\_representation =>  
 shape\_definition\_representation}  
 property\_definition\_representation  
 property\_definition\_representation.used\_representation ->  
 {representation =>

```

shape_representation}
representation
representation.items [i] ->
{representation_item
representation_item.name = 'centreline orientation'}
representation_item =>
geometric_representation_item
placement =>
axis2_placement_3d

```

### 5.1.9.35 Perforated\_cap

#1: The attributes are for the individual piping component.

#2: The attributes are for the definition of a family of piping components.

AIM element:	#1: (piping_component_definition) #2: (piping_component_class)
Source:	227
Rules:	dependent_instantiable_product_context product_context_discipline_type_constraint value_for_application_context
Reference path:	#1: (piping_component_definition <= product_definition {piping_component_definition classification_item = piping_component_definition classification_item <= applied_classification_assignment.items[i] applied_classification_assignment <= classification_assignment classification_assignment.assigned_classification -> [group => pipe_closure_fitting_class] [group group.name = 'perforated cap'] [group <= group_relationship.related_group {group_relationship group_relationship.name = 'class hierarchy'} group_relationship group_relationship.relating_group -> group group.name = 'cap']}) {product_definition product_definition.formation -> product_definition_formation product_definition_formation.of_product -> [product classification_item = product classification_item <= applied_classification_assignment.items[i] applied_classification_assignment <=

```

{classification_assignment
classification_assignment.role ->
group_role
group_role.name = 'plant item type'}
classification_assignment
classification_assignment.assigned_classification ->
(group)
(group <-
group_relationship.related_group
group_relationship
group_relationship.relying_group ->
group)
group.name = 'perforated cap']
[product
product.frame_of_reference[i] ->
product_context<=
application_context_element
application_context_element.name = 'plant item']})
#2: (piping_component_class <=
[characterized_object]
[group])
{[group =>
pipe_closure_fitting_class]
[(group)
(group <-
group_relationship.related_group
group_relationship
group_relationship.relying_group ->
group)
group.name = 'perforated cap']
[group <-
group_relationship.related_group
{group_relationship
group_relationship.name = 'class hierarchy'}
group_relationship
group_relationship.relying_group ->
group
group.name = 'cap']]}
```

### 5.1.9.35.1 end\_2\_connector

AIM element: plant\_item\_connector

Source: 227

Reference path: piping\_component\_definition <=
product\_definition
characterized\_product\_definition = product\_definition
characterized\_product\_definition
characterized\_definition = characterized\_product\_definition
characterized\_definition <-
property\_definition.definition
property\_definition =>
product\_definition\_shape <-

```

shape_aspect.of_shape
{ shape_aspect
shape_aspect.description = 'end 2' }
shape_aspect =>
plant_item_connector

```

### 5.1.9.35.2 hole\_diameter

#1: The attributes are for the individual piping component.

#2: The attributes are for the definition of a family of piping components.

AIM element: [measure\_with\_unit.value\_component]  
[measure\_with\_unit.unit\_component]

Source: 41

Rules: subtype\_exclusive\_characterized\_object  
subtype\_mandatory\_shape\_representation

Reference path: #1: (piping\_component\_definition <=  
product\_definition  
characterized\_product\_definition = product\_definition  
characterized\_product\_definition  
characterized\_definition = characterized\_product\_definition  
characterized\_definition <=  
property\_definition.definition  
property\_definition =>  
product\_definition\_shape <=  
shape\_aspect.of\_shape  
[shape\_aspect <=  
dimensional\_size.applies\_to  
dimensional\_size  
dimensional\_characteristic = dimensional\_size  
dimensional\_characteristic <=  
dimensional\_characteristic\_representation.dimension  
dimensional\_characteristic\_representation  
dimensional\_characteristic\_representation.representation ->  
shape\_dimension\_representation <=  
shape\_representation <=  
{representation  
representation.name = 'pipe closure fitting dimensional shape'}  
representation  
representation.items[i] ->  
{representation\_item  
representation\_item.name = 'hole diameter'})  
#2: (piping\_component\_class <=  
characterized\_object  
characterized\_definition = characterized\_object  
characterized\_definition <=  
property\_definition.definition  
property\_definition  
represented\_definition = property\_definition

```

represented_definition <-
property_definition_representation.definition
property_definition_representation
property_definition_representation.used_representation ->
{representation
representation.name = 'pipe closure fitting class dimensions'}
representation
(representation.items[i] ->
{representation_item
(representation_item.name = 'maximum hole diameter')
(representation_item.name = 'minimum hole diameter')}}
([representation.items[i] ->
{representation_item
representation_item.name = 'maximum hole diameter'}}
[representation.items[i] ->
{representation_item
representation_item.name = 'minimum hole diameter'}}]))
representation_item =>
measure_representation_item <=
{measure_with_unit =>
length_measure_with_unit}
measure_with_unit
[measure_with_unit.value_component]
[measure_with_unit.unit_component]

```

### 5.1.9.36 Orifice\_plate

#1: The attributes are for the individual piping component.

#2: The attributes are for the definition of a family of piping components.

AIM element: #1: (piping\_component\_definition)  
#2: (piping\_component\_class)

Source: 227

Rules: dependent\_instantiable\_product\_context  
product\_context\_discipline\_type\_constraint  
value\_for\_application\_context

Reference path: #1: (piping\_component\_definition <=  
product\_definition  
{product\_definition  
product\_definition.formation ->  
product\_definition\_formation  
product\_definition\_formation.of\_product ->  
[product  
classification\_item = product  
classification\_item <-  
applied\_classification\_assignment.items[i]  
applied\_classification\_assignment <=  
classification\_assignment  
classification\_assignment.assigned\_classification ->

(group)

```

(group <-
group_relationship.related_group
group_relationship
group_relationship.relying_group ->
group)
group.name = 'orifice plate']
[product
product.frame_of_reference[i] ->
product_context<=
application_context_element
application_context_element.name = 'plant item']]
#2: (piping_component_class <=
[characterized_object]
[group])
227

```

### 5.1.9.36.1 **beta\_ratio**

AIM element: [measure\_with\_unit.value\_component]  
[measure\_with\_unit.unit\_component]

Source: 41

Reference path: piping\_component\_definition <=  
product\_definition  
characterized\_product\_definition = product\_definition  
characterized\_product\_definition  
characterized\_definition = characterized\_product\_definition  
characterized\_definition <=  
property\_definition.definition  
property\_definition  
represented\_definition = property\_definition  
represented\_definition <=  
property\_definition\_representation.definition  
property\_definition\_representation  
property\_definition\_representation.used\_representation ->  
representation  
representation.items[i] ->  
{representation\_item  
representation\_item.name = 'beta ratio'}  
representation\_item =>  
measure\_representation\_item <=  
{measure\_with\_unit =>  
ratio\_measure\_with\_unit}  
measure\_with\_unit  
[measure\_with\_unit.value\_component]  
[measure\_with\_unit.unit\_component]

### 5.1.9.36.2 **bore\_diameter**

#1: The attributes are for the individual piping component.

#2: The attributes are for the definition of a family of piping components.

AIM element: [measure\_with\_unit.value\_component]  
[measure\_with\_unit.unit\_component]

Source: 41

Rules: subtype\_exclusive\_characterized\_object  
subtype\_mandatory\_shape\_representation

Reference path: #1: (piping\_component\_definition <=  
product\_definition  
characterized\_product\_definition = product\_definition  
characterized\_product\_definition  
characterized\_definition = characterized\_product\_definition  
characterized\_definition <=  
property\_definition.definition  
property\_definition =>  
product\_definition\_shape <=  
shape\_aspect.of\_shape  
shape\_aspect <=  
dimensional\_size.applies\_to  
dimensional\_size  
dimensional\_characteristic = dimensional\_size  
dimensional\_characteristic <=  
dimensional\_characteristic\_representation.dimension  
dimensional\_characteristic\_representation  
dimensional\_characteristic\_representation.representation ->  
shape\_dimension\_representation <=  
shape\_representation <=  
{representation  
representation.name = 'orifice plate fitting dimensional shape'}  
representation  
representation.items[i] ->  
{representation\_item  
representation\_item.name = 'bore diameter'})  
#2: (piping\_component\_class <=  
characterized\_object  
characterized\_definition = characterized\_object  
characterized\_definition <=  
property\_definition.definition  
property\_definition  
represented\_definition = property\_definition  
represented\_definition <=  
property\_definition\_representation.definition  
property\_definition\_representation  
property\_definition\_representation.used\_representation ->  
{representation  
representation.name = 'orifice plate fitting class dimensions'}  
representation  
(representation.items[i] ->  
{representation\_item  
(representation\_item.name = 'maximum bore diameter')  
(representation\_item.name = 'minimum bore diameter'))})

```

([representation.items[i] ->
 {representation_item
 representation_item.name = 'maximum bore diameter'}}]
[representation.items[i] ->
 {representation_item
 representation_item.name = 'minimum bore diameter'}}]))
representation_item =>
measure_representation_item <=
 {measure_with_unit =>
 length_measure_with_unit}
measure_with_unit
[measure_with_unit.value_component]
[measure_with_unit.unit_component]

```

### 5.1.9.36.3 outside\_diameter

#1: The attributes are for the individual piping component.

#2: The attributes are for the definition of a family of piping components.

AIM element: [measure\_with\_unit.value\_component]  
[measure\_with\_unit.unit\_component]

Source: 41

Rules: subtype\_exclusive\_characterized\_object  
subtype\_mandatory\_shape\_representation

Reference path: #1: (piping\_component\_definition <=  
product\_definition  
characterized\_product\_definition = product\_definition  
characterized\_product\_definition  
characterized\_definition = characterized\_product\_definition  
characterized\_definition <=  
property\_definition.definition  
property\_definition =>  
product\_definition\_shape <=  
shape\_aspect.of\_shape  
shape\_aspect <=  
dimensional\_size.applies\_to  
dimensional\_size  
dimensional\_characteristic = dimensional\_size  
dimensional\_characteristic <=  
dimensional\_characteristic\_representation.dimension  
dimensional\_characteristic\_representation  
dimensional\_characteristic\_representation.representation ->  
shape\_dimension\_representation <=  
shape\_representation <=  
{representation  
representation.name = 'orifice plate fitting dimensional shape'}  
representation  
representation.items[i] ->  
{representation\_item  
representation\_item.name = 'outside diameter'}})

```

#2: (piping_component_class <=
characterized_object
characterized_definition = characterized_object
characterized_definition <-
property_definition.definition
property_definition
represented_definition = property_definition
represented_definition <-
property_definition_representation.definition
property_definition_representation
property_definition_representation.used_representation ->
{representation
representation.name = 'orifice plate fitting class dimensions'}
representation
(representation.items[i] ->
{representation_item
(representation_item.name = 'maximum outside diameter')
(representation_item.name = 'minimum outside diameter')}}
([representation.items[i] ->
{representation_item
representation_item.name = 'maximum outside diameter'}}
[representation.items[i] ->
{representation_item
representation_item.name = 'minimum outside diameter'}}]))
representation_item =>
measure_representation_item <=
{measure_with_unit =>
length_measure_with_unit}
measure_with_unit
[measure_with_unit.value_component]
[measure_with_unit.unit_component]

```

#### 5.1.9.36.4 thickness

#1: The attributes are for the individual piping component.

#2: The attributes are for the definition of a family of piping components.

AIM element: [measure\_with\_unit.value\_component]  
[measure\_with\_unit.unit\_component]

Source: 41

Rules: subtype\_exclusive\_characterized\_object  
subtype\_mandatory\_shape\_representation

Reference path: #1: (piping\_component\_definition <=
product\_definition
characterized\_product\_definition = product\_definition
characterized\_product\_definition
characterized\_definition = characterized\_product\_definition
characterized\_definition <-
property\_definition.definition
property\_definition =>

```

product_definition_shape <-
shape_aspect.of_shape
[shape_aspect <-
shape_aspect_relationship.relating_shape_aspect]
[shape_aspect <-
shape_aspect_relationship.related_shape_aspect]
shape_aspect_relationship =>
dimensional_location
dimensional_characteristic = dimensional_location
dimensional_characteristic <-
dimensional_characteristic_representation.dimension
dimensional_characteristic_representation
dimensional_characteristic_representation.representation ->
shape_dimension_representation <=
shape_representation <=
{representation
representation.name = 'orifice plate fitting dimensional shape'}
representation
representation.items[i] ->
{representation_item
representation_item.name = 'thickness'})
#2: (piping_component_class <=
characterized_object
characterized_definition = characterized_object
characterized_definition <-
property_definition.definition
property_definition
represented_definition = property_definition
represented_definition <-
property_definition_representation.definition
property_definition_representation
property_definition_representation.used_representation ->
{representation
representation.name = 'orifice plate fitting class dimensions'}
representation
(representation.items[i] ->
{representation_item
(representation_item.name = 'maximum thickness')
(representation_item.name = 'minimum thickness'))}
([representation.items[i] ->
{representation_item
representation_item.name = 'maximum thickness'}]
[representation.items[i] ->
{representation_item
representation_item.name = 'minimum thickness'}}))
representation_item =>
measure_representation_item <=
{measure_with_unit =>
length_measure_with_unit}
measure_with_unit
[measure_with_unit.value_component]
[measure_with_unit.unit_component]

```

### 5.1.9.37 Outside\_and\_thickness

#1: The attributes are for the individual piping component.

#2: The attributes are for the definition of a family of piping components.

AIM element: #1: (shape\_dimension\_representation)  
#2: (representation)

Source: 43, 47

Reference path: #1: ({ shape\_dimension\_representation <=  
shape\_representation <=  
[representation  
representation.name = 'piping component dimensions']  
[representation <=  
property\_definition\_representation.used\_representation  
property\_definition\_representation  
property\_definition\_representation.definition ->  
(represented\_definition  
represented\_definition = property\_definition  
{property\_definition =>  
product\_definition\_shape}  
property\_definition  
property\_definition.definition ->  
characterized\_definition  
characterized\_definition = characterized\_product\_definition  
characterized\_product\_definition  
characterized\_product\_definition = product\_definition  
product\_definition =>  
piping\_component\_definition)  
(represented\_definition  
represented\_definition = shape\_aspect  
shape\_aspect =>  
plant\_item\_connector))})  
#2: ({[representation  
representation.name = 'piping component class size']  
[representation <=  
property\_definition\_representation.used\_representation  
property\_definition\_representation  
property\_definition\_representation.definition ->  
represented\_definition  
represented\_definition = property\_definition  
property\_definition  
property\_definition.definition ->  
characterized\_definition  
characterized\_definition = characterized\_object  
characterized\_object =>  
piping\_component\_class]})

#### 5.1.9.37.1 outside\_diameter

#1: The attributes are for the individual piping component.

#2: The attributes are for the definition of a family of piping components.

AIM element: [measure\_with\_unit.value\_component]  
[measure\_with\_unit.unit\_component]

Source: 41

Rules: subtype\_mandatory\_shape\_representation

Reference path: #1: (shape\_dimension\_representation <=  
shape\_representation <=  
representation  
representation.items[i] ->  
{representation\_item  
representation\_item.name = 'outside diameter'})  
#2: (representation  
(representation.items[i] ->  
{representation\_item  
(representation\_item.name = 'maximum outside diameter')  
(representation\_item.name = 'minimum outside diameter')})  
([representation.items[i] ->  
{representation\_item  
representation\_item.name = 'maximum outside diameter'}}]  
[representation.items[i] ->  
{representation\_item  
representation\_item.name = 'minimum outside diameter'}}])  
representation\_item =>  
measure\_representation\_item <=  
{measure\_with\_unit =>  
length\_measure\_with\_unit}  
measure\_with\_unit  
[measure\_with\_unit.value\_component]  
[measure\_with\_unit.unit\_component]

### 5.1.9.37.2 thickness

#1: The attributes are for the individual piping component.

#2: The attributes are for the definition of a family of piping components.

AIM element: [measure\_with\_unit.value\_component]  
[measure\_with\_unit.unit\_component]

Source: 41

Rules: subtype\_mandatory\_shape\_representation

Reference path: #1: (shape\_dimension\_representation <=  
shape\_representation <=  
representation  
representation.items[i] ->  
{representation\_item  
representation\_item.name = 'thickness'})  
#2: (representation

```

(representation.items[i] ->
{representation_item
(representation_item.name = 'maximum thickness')
(representation_item.name = 'minimum thickness'))
([representation.items[i] ->
{representation_item
representation_item.name = 'maximum thickness'}]
[representation.items[i] ->
{representation_item
representation_item.name = 'minimum thickness'}]))
representation_item =>
measure_representation_item <=
{measure_with_unit =>
length_measure_with_unit}
measure_with_unit
[measure_with_unit.value_component]
[measure_with_unit.unit_component]

```

### 5.1.9.38 Paddle\_blank

#1: The attributes are for the individual piping component.

#2: The attributes are for the definition of a family of piping components.

AIM element: #1: (piping\_component\_definition)  
#2: (piping\_component\_class)

Source: 227

Rules: dependent\_instantiable\_product\_context  
product\_context\_discipline\_type\_constraint  
value\_for\_application\_context

Reference path: #1: (piping\_component\_definition <=  
product\_definition  
{piping\_component\_definition  
classification\_item = piping\_component\_definition  
classification\_item <=  
applied\_classification\_assignment.items[i]  
applied\_classification\_assignment <=  
classification\_assignment  
classification\_assignment.assigned\_classification ->  
[group =>  
blank\_fitting\_class]  
[group  
group.name = 'paddle blank']}  
{product\_definition  
product\_definition.formation ->  
product\_definition\_formation  
product\_definition\_formation.of\_product ->  
[product  
classification\_item = product  
classification\_item <=  
applied\_classification\_assignment.items[i]

```

applied_classification_assignment <=
classification_assignment
classification_assignment.assigned_classification ->
(group)
(group <-
group_relationship.related_group
group_relationship
group_relationship.relying_group ->
group)
group.name = 'blank']
[product
product.frame_of_reference[i] ->
product_context<=
application_context_element
application_context_element.name = 'plant item']]
227
#2: (piping_component_class <=
[characterized_object]
[group])

```

### 5.1.9.38.1 paddle\_length

#1: The attributes are for the individual piping component.

#2: The attributes are for the definition of a family of piping components.

AIM element: [measure\_with\_unit.value\_component]  
[measure\_with\_unit.unit\_component]

Source: 41

Rules: subtype\_exclusive\_characterized\_object  
subtype\_mandatory\_shape\_representation

Reference path: #1: (piping\_component\_definition <=
product\_definition
characterized\_product\_definition = product\_definition
characterized\_product\_definition
characterized\_definition = characterized\_product\_definition
characterized\_definition <-
property\_definition.definition
property\_definition =>
product\_definition\_shape <-
shape\_aspect.of\_shape
[shape\_aspect <-
shape\_aspect\_relationship.relying\_shape\_aspect]
[shape\_aspect <-
shape\_aspect\_relationship.related\_shape\_aspect]
shape\_aspect\_relationship =>
dimensional\_location
dimensional\_characteristic = dimensional\_location
dimensional\_characteristic <-
dimensional\_characteristic\_representation.dimensional
dimensional\_characteristic\_representation

```

dimensional_characteristic_representation.representation ->
shape_dimension_representation <=
shape_representation <=
{representation
representation.name = 'blank fitting dimensional shape'}
representation
representation.items[i] ->
{representation_item
representation_item.name = 'paddle length'}}
#2: (piping_component_class <=
characterized_object
characterized_definition = characterized_object
characterized_definition <-
property_definition.definition
property_definition
represented_definition = property_definition
represented_definition <-
property_definition_representation.definition
property_definition_representation
property_definition_representation.used_representation ->
{representation
representation.name = 'blank fitting class dimensions'}
representation
(representation.items[i] ->
{representation_item
(representation_item.name = 'maximum paddle length')
(representation_item.name = 'minimum paddle length'}})
([representation.items[i] ->
{representation_item
representation_item.name = 'maximum paddle length'}}
[representation.items[i] ->
{representation_item
representation_item.name = 'minimum paddle length'}}]))
representation_item =>
measure_representation_item <=
{measure_with_unit =>
length_measure_with_unit}
measure_with_unit
[measure_with_unit.value_component]
[measure_with_unit.unit_component]

```

### 5.1.9.38.2 paddle\_width

#1: The attributes are for the individual piping component.

#2: The attributes are for the definition of a family of piping components.

AIM element: [measure\_with\_unit.value\_component]  
[measure\_with\_unit.unit\_component]

Source: 41

Rules: subtype\_exclusive\_characterized\_object

subtype\_mandatory\_shape\_representation

Reference path: #1: (piping\_component\_definition <=  
product\_definition  
characterized\_product\_definition = product\_definition  
characterized\_product\_definition  
characterized\_definition = characterized\_product\_definition  
characterized\_definition <=  
property\_definition.definition  
property\_definition =>  
product\_definition\_shape <=  
shape\_aspect.of\_shape  
[shape\_aspect <=  
shape\_aspect\_relationship.relate\_shape\_aspect]  
[shape\_aspect <=  
shape\_aspect\_relationship.related\_shape\_aspect]  
shape\_aspect\_relationship =>  
dimensional\_location  
dimensional\_characteristic = dimensional\_location  
dimensional\_characteristic <=  
dimensional\_characteristic\_representation.dimension  
dimensional\_characteristic\_representation  
dimensional\_characteristic\_representation.representation ->  
shape\_dimension\_representation <=  
shape\_representation <=  
{representation  
representation.name = 'blank fitting dimensional shape'}  
representation  
representation.items[i] ->  
{representation\_item  
representation\_item.name = 'paddle width'})  
#2: (piping\_component\_class <=  
characterized\_object  
characterized\_definition = characterized\_object  
characterized\_definition <=  
property\_definition.definition  
property\_definition  
represented\_definition = property\_definition  
represented\_definition <=  
property\_definition\_representation.definition  
property\_definition\_representation  
property\_definition\_representation.used\_representation ->  
{representation  
representation.name = 'blank fitting class dimensions'}  
representation  
(representation.items[i] ->  
{representation\_item  
(representation\_item.name = 'maximum paddle width')  
(representation\_item.name = 'minimum paddle width'}})  
([representation.items[i] ->  
{representation\_item  
representation\_item.name = 'maximum paddle width'}]  
[representation.items[i] ->  
{representation\_item

```

representation_item.name = 'minimum paddle width'}}))
representation_item =>
measure_representation_item <=
{measure_with_unit =>
length_measure_with_unit}
measure_with_unit
[measure_with_unit.value_component]
[measure_with_unit.unit_component]

```

### 5.1.9.39 Paddle\_spacer

#1: The attributes are for the individual piping component.

#2: The attributes are for the definition of a family of piping components.

AIM element: #1: (piping\_component\_definition)  
#2: (piping\_component\_class)

Source: 227

Rules: dependent\_instantiable\_product\_context  
product\_context\_discipline\_type\_constraint  
value\_for\_application\_context

Reference path: #1: (piping\_component\_definition <=  
product\_definition  
{piping\_component\_definition  
classification\_item = piping\_component\_definition  
classification\_item <=  
applied\_classification\_assignment.items[i]  
applied\_classification\_assignment <=  
classification\_assignment  
classification\_assignment.assigned\_classification ->  
[group =>  
spacer\_fitting\_class]  
[group  
group.name = 'paddle spacer']}  
{product\_definition  
product\_definition.formation ->  
product\_definition\_formation  
product\_definition\_formation.of\_product ->  
[product  
classification\_item = product  
classification\_item <=  
applied\_classification\_assignment.items[i]  
applied\_classification\_assignment <=  
classification\_assignment  
classification\_assignment.assigned\_classification ->  
(group)  
(group <=  
group\_relationship.related\_group  
group\_relationship  
group\_relationship.relating\_group ->  
group)

```

group.name = 'spacer']
[product
product.frame_of_reference[i] ->
product_context<=
application_context_element
application_context_element.name = 'plant item']]
#2: (piping_component_class <=
[characterized_object]
[group])

```

### 5.1.9.39.1 inside\_diameter

#1: The attributes are for the individual piping component.

#2: The attributes are for the definition of a family of piping components.

AIM element: [measure\_with\_unit.value\_component]  
[measure\_with\_unit.unit\_component]

Source: 41

Rules: subtype\_exclusive\_characterized\_object  
subtype\_mandatory\_shape\_representation

Reference path: #1: (piping\_component\_definition <=
product\_definition
characterized\_product\_definition = product\_definition
characterized\_product\_definition
characterized\_definition = characterized\_product\_definition
characterized\_definition <-
property\_definition.definition
property\_definition =>
product\_definition\_shape <-
shape\_aspect.of\_shape
shape\_aspect <-
dimensional\_size.applies\_to
dimensional\_size
dimensional\_characteristic = dimensional\_size
dimensional\_characteristic <-
dimensional\_characteristic\_representation.dimension
dimensional\_characteristic\_representation
dimensional\_characteristic\_representation.representation ->
shape\_dimension\_representation <=
shape\_representation <=
{representation
representation.name = 'spacer fitting dimensional shape'}
representation
representation.items[i] ->
{representation\_item
representation\_item.name = 'inside diameter'})
#2: (piping\_component\_class <=
characterized\_object
characterized\_definition = characterized\_object
characterized\_definition <-

```

property_definition.definition
property_definition
represented_definition = property_definition
represented_definition <-
property_definition_representation.definition
property_definition_representation
property_definition_representation.used_representation ->
{representation
representation.name = 'spacer fitting class dimensions'}
representation
(representation.items[i] ->
{representation_item
(representation_item.name = 'maximum inside diameter')
(representation_item.name = 'minimum inside diameter')}})
([representation.items[i] ->
{representation_item
representation_item.name = 'maximum inside diameter'}}]
[representation.items[i] ->
{representation_item
representation_item.name = 'minimum inside diameter'}}]))
representation_item =>
measure_representation_item <=
{measure_with_unit =>
length_measure_with_unit}
measure_with_unit
[measure_with_unit.value_component]
[measure_with_unit.unit_component]

```

### 5.1.9.39.2 paddle\_length

#1: The attributes are for the individual piping component.

#2: The attributes are for the definition of a family of piping components.

AIM element: [measure\_with\_unit.value\_component]  
[measure\_with\_unit.unit\_component]

Source: 41

Rules: subtype\_exclusive\_characterized\_object  
subtype\_mandatory\_shape\_representation

Reference path: #1: (piping\_component\_definition <=  
product\_definition  
characterized\_product\_definition = product\_definition  
characterized\_product\_definition  
characterized\_definition = characterized\_product\_definition  
characterized\_definition <-  
property\_definition.definition  
property\_definition =>  
product\_definition\_shape <-  
shape\_aspect.of\_shape  
[shape\_aspect <-  
shape\_aspect\_relationship.relating\_shape\_aspect]

```

[shape_aspect <-
shape_aspect_relationship.related_shape_aspect]
shape_aspect_relationship =>
dimensional_location
dimensional_characteristic = dimensional_location
dimensional_characteristic <-
dimensional_characteristic_representation.dimension
dimensional_characteristic_representation
dimensional_characteristic_representation.representation ->
shape_dimension_representation <=
shape_representation <=
{representation
representation.name = 'spacer fitting dimensional shape'}
representation
representation.items[i] ->
{representation_item
representation_item.name = 'paddle length'})
#2: (piping_component_class <=
characterized_object
characterized_definition = characterized_object
characterized_definition <-
property_definition.definition
property_definition
represented_definition = property_definition
represented_definition <-
property_definition_representation.definition
property_definition_representation
property_definition_representation.used_representation ->
{representation
representation.name = 'spacer fitting class dimensions'}
representation
(representation.items[i] ->
{representation_item
(representation_item.name = 'maximum paddle length')
(representation_item.name = 'minimum paddle length'))
([representation.items[i] ->
{representation_item
representation_item.name = 'maximum paddle length'}]
[representation.items[i] ->
{representation_item
representation_item.name = 'minimum paddle length'}]))
representation_item =>
measure_representation_item <=
{measure_with_unit =>
length_measure_with_unit}
measure_with_unit
[measure_with_unit.value_component]
[measure_with_unit.unit_component]

```

### 5.1.9.39.3 paddle\_width

#1: The attributes are for the individual piping component.

#2: The attributes are for the definition of a family of piping components.

AIM element: [measure\_with\_unit.value\_component]  
[measure\_with\_unit.unit\_component]

Source: 41

Rules: subtype\_exclusive\_characterized\_object  
subtype\_mandatory\_shape\_representation

Reference path: #1: (piping\_component\_definition <=  
product\_definition  
characterized\_product\_definition = product\_definition  
characterized\_product\_definition  
characterized\_definition = characterized\_product\_definition  
characterized\_definition <=  
property\_definition.definition  
property\_definition =>  
product\_definition\_shape <=  
shape\_aspect.of\_shape  
[shape\_aspect <=  
shape\_aspect\_relationship.relating\_shape\_aspect]  
[shape\_aspect <=  
shape\_aspect\_relationship.related\_shape\_aspect]  
shape\_aspect\_relationship =>  
dimensional\_location  
dimensional\_characteristic = dimensional\_location  
dimensional\_characteristic <=  
dimensional\_characteristic\_representation.dimension  
dimensional\_characteristic\_representation  
dimensional\_characteristic\_representation.representation ->  
shape\_dimension\_representation <=  
shape\_representation <=  
{representation  
representation.name = 'spacer fitting dimensional shape'}  
representation  
representation.items[i] ->  
{representation\_item  
representation\_item.name = 'paddle width'})  
#2: (piping\_component\_class <=  
characterized\_object  
characterized\_definition = characterized\_object  
characterized\_definition <=  
property\_definition.definition  
property\_definition  
represented\_definition = property\_definition  
represented\_definition <=  
property\_definition\_representation.definition  
property\_definition\_representation  
property\_definition\_representation.used\_representation ->  
{representation  
representation.name = 'spacer fitting class dimensions'}  
representation  
(representation.items[i] ->

```

{representation_item
(representation_item.name = 'maximum paddle width')
(representation_item.name = 'minimum paddle width'))
([representation.items[i] ->
{representation_item
representation_item.name = 'maximum paddle width'}]
[representation.items[i] ->
{representation_item
representation_item.name = 'minimum paddle width'}}))
representation_item =>
measure_representation_item <=
{measure_with_unit =>
length_measure_with_unit}
measure_with_unit
[measure_with_unit.value_component]
[measure_with_unit.unit_component]

```

### 5.1.9.40 Perforated\_plate

#1: The attributes are for the individual piping component.

#2: The attributes are for the definition of a family of piping components.

AIM element: #1: (piping\_component\_definition)  
#2: (piping\_component\_class)

Source: 227

Rules: dependent\_instantiable\_product\_context  
product\_context\_discipline\_type\_constraint  
value\_for\_application\_context

Reference path: #1: (piping\_component\_definition <= product\_definition  
{piping\_component\_definition  
classification\_item = piping\_component\_definition  
classification\_item <-  
applied\_classification\_assignment.items[i]  
applied\_classification\_assignment <= classification\_assignment  
classification\_assignment.assigned\_classification ->  
[group =>  
pipe\_closure\_fitting\_class]  
[group  
group.name = 'perforated plate']  
[group <-  
group\_relationship.related\_group  
{group\_relationship  
group\_relationship.name = 'class hierarchy'}  
group\_relationship  
group\_relationship.relating\_group ->  
group  
group.name = 'plate']}]}

```

product_definition.formation ->
product_definition_formation
product_definition_formation.of_product ->
[product
classification_item = product
classification_item <-
applied_classification_assignment.items[i]
applied_classification_assignment <=
{classification_assignment
classification_assignment.role ->
group_role
group_role.name = 'plant item type'}
classification_assignment
classification_assignment.assigned_classification ->
(group)
(group <-
group_relationship.related_group
group_relationship
group_relationship.relating_group ->
group)
group.name = 'perforated plate']
[product
product.frame_of_reference[i] ->
product_context<=
application_context_element
application_context_element.name = 'plant item']]
#2: (piping_component_class <=
[characterized_object]
[group])
{[group =>
pipe_closure_fitting_class]
[(group)
(group <-
group_relationship.related_group
group_relationship
group_relationship.relating_group ->
group)
group.name = 'perforated plate']
[group <-
group_relationship.related_group
{group_relationship
group_relationship.name = 'class hierarchy'}
group_relationship
group_relationship.relating_group ->
group
group.name = ' plate']]

```

#### 5.1.9.40.1 end\_2\_connector

AIM element: plant\_item\_connector

Source: 227

Reference path:    piping\_component\_definition <=  
                          product\_definition  
                          characterized\_product\_definition = product\_definition  
                          characterized\_product\_definition  
                          characterized\_definition = characterized\_product\_definition  
                          characterized\_definition <=  
                          property\_definition.definition  
                          property\_definition =>  
                          product\_definition\_shape <=  
                          shape\_aspect.of\_shape  
                          {shape\_aspect  
                          shape\_aspect.description = 'end 2'}  
                          shape\_aspect =>  
                          plant\_item\_connector

### 5.1.9.40.2    hole\_diameter

#1: The attributes are for the individual piping component.

#2: The attributes are for the definition of a family of piping components.

AIM element:        [measure\_with\_unit.value\_component]  
                          [measure\_with\_unit.unit\_component]

Source:              41

Rules:                subtype\_exclusive\_characterized\_object  
                          subtype\_mandatory\_shape\_representation

Reference path:    #1: (piping\_component\_definition <=  
                          product\_definition  
                          characterized\_product\_definition = product\_definition  
                          characterized\_product\_definition  
                          characterized\_definition = characterized\_product\_definition  
                          characterized\_definition <=  
                          property\_definition.definition  
                          property\_definition =>  
                          product\_definition\_shape <=  
                          shape\_aspect.of\_shape  
                          [shape\_aspect <=  
                          dimensional\_size.applies\_to  
                          dimensional\_size  
                          dimensional\_characteristic = dimensional\_size  
                          dimensional\_characteristic <=  
                          dimensional\_characteristic\_representation.dimension  
                          dimensional\_characteristic\_representation  
                          dimensional\_characteristic\_representation.representation ->  
                          shape\_dimension\_representation <=  
                          shape\_representation <=  
                          {representation  
                          representation.name = 'pipe closure fitting dimensional shape'}  
                          representation  
                          representation.items[i] ->  
                          {representation\_item

```

representation_item.name = 'hole diameter'})
#2: (piping_component_class <=
characterized_object
characterized_definition = characterized_object
characterized_definition <-
property_definition.definition
property_definition
represented_definition = property_definition
represented_definition <-
property_definition_representation.definition
property_definition_representation
property_definition_representation.used_representation ->
{representation
representation.name = 'pipe closure fitting class dimensions'}
representation
(representation.items[i] ->
{representation_item
(representation_item.name = 'maximum hole diameter')
(representation_item.name = 'minimum hole diameter'}})
([representation.items[i] ->
{representation_item
representation_item.name = 'maximum hole diameter'}}
[representation.items[i] ->
{representation_item
representation_item.name = 'minimum hole diameter'}})])
representation_item =>
measure_representation_item <=
{measure_with_unit =>
length_measure_with_unit}
measure_with_unit
[measure_with_unit.value_component]
[measure_with_unit.unit_component]

```

### 5.1.9.41 Pipe

#1: The attributes are for the individual piping component.

#2: The attributes are for the definition of a family of piping components.

AIM element:       #1: (piping\_component\_definition)  
                      #2: (piping\_component\_class)

Source:             227

Rules:              dependent\_instantiable\_product\_context  
                      product\_context\_discipline\_type\_constraint  
                      value\_for\_application\_context

Reference path:     (piping\_component\_definition <=
                      product\_definition
                      {product\_definition
                      product\_definition.formation ->
                      product\_definition\_formation
                      product\_definition\_formation.of\_product ->

```

[product
classification_item = product
classification_item <-
applied_classification_assignment.items[i]
applied_classification_assignment <=
classification_assignment
classification_assignment.assigned_classification ->
(group)
(group <-
group_relationship.related_group
group_relationship
group_relationship.relatng_group ->
group)
group.name = 'pipe'']]
[product
product.frame_of_reference[i] ->
product_context<=
application_context_element
application_context_element.name = 'plant item']]
(piping_component_class <=
[characterized_object]
[group])

```

#### 5.1.9.41.1 end\_1\_connector

AIM element: plant\_item\_connector

Source: 227

Reference path: #1: (piping\_component\_definition <=

```

product_definition
characterized_product_definition
characterized_definition = characterized_product_definition)
#2: (piping_component_class <=
[characterized_object]
[group]
characterized_definition = characterized_object)
characterized_definition <-
property_definition.definition
product_definition
characterized_product_definition = product_definition
characterized_product_definition
characterized_definition = characterized_product_definition
characterized_definition <-
property_definition.definition
property_definition =>
product_definition_shape <-
shape_aspect.of_shape
{shape_aspect
shape_aspect.description = 'end 1'}
shape_aspect =>
plant_item_connector

```

**5.1.9.41.2 end\_2\_connector**

AIM element: plant\_item\_connector

Source: 227

Reference path: #1: (piping\_component\_definition <=  
product\_definition  
characterized\_product\_definition  
characterized\_definition = characterized\_product\_definition)  
#2: (piping\_component\_class <=  
[characterized\_object]  
[group]  
characterized\_definition = characterized\_object)  
characterized\_definition <=  
property\_definition.definition  
product\_definition  
characterized\_product\_definition = product\_definition  
characterized\_product\_definition  
characterized\_definition = characterized\_product\_definition  
characterized\_definition <=  
property\_definition.definition  
property\_definition =>  
product\_definition\_shape <=  
shape\_aspect.of\_shape  
{shape\_aspect  
shape\_aspect.description = 'end 2'}  
shape\_aspect =>  
plant\_item\_connector

**5.1.9.41.3 additional\_length**

#1: The attributes are for the individual piping component.

#2: The attributes are for the definition of a family of piping components.

AIM element: [measure\_with\_unit.value\_component]  
[measure\_with\_unit.unit\_component]

Source: 41

Rules: subtype\_exclusive\_characterized\_object  
subtype\_mandatory\_shape\_representation

Reference path: #1: (piping\_component\_definition <=  
product\_definition  
characterized\_product\_definition = product\_definition  
characterized\_product\_definition  
characterized\_definition = characterized\_product\_definition  
characterized\_definition <=  
property\_definition.definition  
property\_definition =>  
product\_definition\_shape <=  
shape\_aspect.of\_shape

```

[shape_aspect <-
shape_aspect_relationship.relateing_shape_aspect]
[shape_aspect <-
shape_aspect_relationship.related_shape_aspect]
shape_aspect_relationship =>
dimensional_location
dimensional_characteristic = dimensional_location
dimensional_characteristic <-
dimensional_characteristic_representation.dimension
dimensional_characteristic_representation
dimensional_characteristic_representation.representation ->
shape_dimension_representation <=
shape_representation <=
{representation
representation.name = 'pipe dimensional shape'}
representation
representation.items[i] ->
{representation_item
representation_item.name = 'additional length'}}
#2: (piping_component_class <=
characterized_object
characterized_definition = characterized_object
characterized_definition <-
property_definition.definition
property_definition
represented_definition = property_definition
represented_definition <-
property_definition_representation.definition
property_definition_representation
property_definition_representation.used_representation ->
{representation
representation.name = 'spacer fitting class dimensions'}
representation
(representation.items[i] ->
{representation_item
(representation_item.name = 'maximum additional length')
(representation_item.name = 'minimum additional length')}})
([representation.items[i] ->
{representation_item
representation_item.name = 'maximum additional length'}}]
[representation.items[i] ->
{representation_item
representation_item.name = 'minimum additional length'}}]))
representation_item =>
measure_representation_item <=
{measure_with_unit =>
length_measure_with_unit}
measure_with_unit
[measure_with_unit.value_component]
[measure_with_unit.unit_component]

```

#### 5.1.9.42 Pipe\_closure

#1: The attributes are for the individual piping component.

#2: The attributes are for the definition of a family of piping components.

AIM element: #1: (piping\_component\_definition)  
#2: (piping\_component\_class)

Source: 227

Rules: dependent\_instantiable\_product\_context  
product\_context\_discipline\_type\_constraint  
value\_for\_application\_context

Reference path: #1: (piping\_component\_definition <=  
product\_definition  
{product\_definition  
product\_definition.formation ->  
product\_definition\_formation  
product\_definition\_formation.of\_product ->  
[product  
classification\_item = product  
classification\_item <=  
applied\_classification\_assignment.items[i]  
applied\_classification\_assignment <=  
classification\_assignment  
classification\_assignment.assigned\_classification ->]  
[product  
product.frame\_of\_reference[i] ->  
(group)  
(group <=  
group\_relationship.related\_group  
group\_relationship  
group\_relationship.relate\_group ->  
group)  
group.name = 'pipe closure']  
product\_context<=  
application\_context\_element  
application\_context\_element.name = 'plant item']})  
  
#2: (piping\_component\_class <=  
[characterized\_object]  
[group])  
{(group)  
(group <=  
group\_relationship.related\_group  
group\_relationship  
group\_relationship.relate\_group ->  
group)  
group.name = 'pipe closure'}

### 5.1.9.42.1 cap\_or\_plug

AIM element: group.name

Source: 41

Reference path: `piping_component_definition`  
`classification_item = piping_component_definition`  
`classification_item <-`  
`applied_classification_assignment.items[i]`  
`applied_classification_assignment <=`  
`classification_assignment`  
`classification_assignment.assigned_classification ->`  
`{group =>`  
`pipe_closure_fitting_class}`  
`group`  
`group.name`  
`{(group.name = 'cap')}`  
`(group.name = 'plug')}`

### 5.1.9.42.2 end\_1\_connector

AIM element: `plant_item_connector`

Source: 227

Reference path: `piping_component_definition <=`  
`product_definition`  
`characterized_product_definition = product_definition`  
`characterized_product_definition`  
`characterized_definition = characterized_product_definition`  
`characterized_definition <-`  
`property_definition.definition`  
`property_definition =>`  
`product_definition_shape <-`  
`shape_aspect.of_shape`  
`{shape_aspect`  
`shape_aspect.description = 'end 1'}`  
`shape_aspect =>`  
`plant_item_connector`

### 5.1.9.42.3 height

#1: The attributes are for the individual piping component.

#2: The attributes are for the definition of a family of piping components.

AIM element: `[measure_with_unit.value_component]`  
`[measure_with_unit.unit_component]`

Source: 41

Rules: `subtype_exclusive_characterized_object`  
`subtype_mandatory_shape_representation`

Reference path: #1: `(piping_component_definition <=`  
`product_definition`

```

characterized_product_definition = product_definition
characterized_product_definition
characterized_definition = characterized_product_definition
characterized_definition <-
property_definition.definition
property_definition =>
product_definition_shape <-
shape_aspect.of_shape
[shape_aspect <-
shape_aspect_relationship.relatng_shape_aspect]
[shape_aspect <-
shape_aspect_relationship.related_shape_aspect]
shape_aspect_relationship =>
dimensional_location
dimensional_characteristic = dimensional_location
dimensional_characteristic <-
dimensional_characteristic_representation.dimension
dimensional_characteristic_representation
dimensional_characteristic_representation.representation ->
shape_dimension_representation <=
shape_representation <=
{representation
representation.name = 'pipe closure fitting dimensional shape'}
representation
representation.items[i] ->
{representation_item
representation_item.name = 'height'})
#2: (piping_component_class <=
characterized_object
characterized_definition = characterized_object
characterized_definition <-
property_definition.definition
property_definition
represented_definition = property_definition
represented_definition <-
property_definition_representation.definition
property_definition_representation
property_definition_representation.used_representation ->
{representation
representation.name = 'pipe closure fitting class dimensions'}
representation
(representation.items[i] ->
{representation_item
(representation_item.name = 'maximum height')
(representation_item.name = 'minimum height'))}
([representation.items[i] ->
{representation_item
representation_item.name = 'maximum height'}]
[representation.items[i] ->
{representation_item
representation_item.name = 'minimum height'}}])
representation_item =>
measure_representation_item <=
{measure_with_unit =>

```

```
length_measure_with_unit}
measure_with_unit
[measure_with_unit.value_component]
[measure_with_unit.unit_component]
```

#### 5.1.9.42.4 **shape\_type**

AIM element: group.description

Source: 41

Reference path:

```
piping_component_definition
classification_item = piping_component_definition
classification_item <-
applied_classification_assignment.items[i]
applied_classification_assignment <=
{classification_assignment
classification_assignment.role ->
classification_role
classification_role.name = 'pipe closure fitting type classification'}
classification_assignment
classification_assignment.assigned_classification ->
{group =>
pipe_closure_fitting_class}
group
group.description
{(group.description = 'square')
(group.description = 'round')}
```

#### 5.1.9.42.5 **end\_1\_connector**

AIM element: plant\_item\_connector

Source: 227

Reference path:

```
piping_component_definition <=
product_definition
characterized_product_definition = product_definition
characterized_product_definition
characterized_definition = characterized_product_definition
characterized_definition <-
property_definition.definition
property_definition =>
product_definition_shape <-
shape_aspect.of_shape
{shape_aspect
shape_aspect.description = 'end 1'}
shape_aspect =>
plant_item_connector
```

### 5.1.9.43 **Piping\_component**

#1: The attributes are for the individual piping component.

#2: The attributes are for the definition of a family of piping components.

AIM element:      #1 (piping\_component\_definition)  
                      #2 (piping\_component\_class)

Source:             227

Rules:              dependent\_instantiable\_product\_context  
                      product\_context\_discipline\_type\_constraint  
                      value\_for\_application\_context

Reference path:    (piping\_component\_definition <=  
                      product\_definition  
                      {product\_definition  
                      product\_definition.formation ->  
                      product\_definition\_formation  
                      product\_definition\_formation.of\_product ->  
                      product  
                      product.frame\_of\_reference[i] ->  
                      product\_context <=  
                      application\_context\_element  
                      application\_context\_element.name = 'plant item'})  
                      (piping\_component\_class <=  
                      [characterized\_object]  
                      [group])

#### **5.1.9.43.1      side\_connector**

AIM element:      plant\_item\_connector

Source:             227

Reference path:    piping\_component\_definition <=  
                      product\_definition  
                      characterized\_product\_definition = product\_definition  
                      characterized\_product\_definition  
                      characterized\_definition = characterized\_product\_definition  
                      characterized\_definition <-  
                      property\_definition.definition  
                      property\_definition =>  
                      product\_definition\_shape <-  
                      shape\_aspect.of\_shape  
                      {shape\_aspect  
                      shape\_aspect.description = 'side'}  
                      shape\_aspect =>  
                      plant\_item\_connector

#### **5.1.9.43.2      standard\_point**

AIM element:      cartesian\_point

Source: 42

Reference path: piping\_component\_definition <=  
product\_definition  
characterized\_product\_definition = product\_definition  
characterized\_product\_definition  
characterized\_definition = characterized\_product\_definition  
characterized\_definition <=  
property\_definition.definition  
property\_definition  
represented\_definition = property\_definition  
represented\_definition <=  
property\_definition\_representation.definition  
property\_definition\_representation  
property\_definition\_representation.used\_representation ->  
{representation  
representation.name = 'internal position'}  
representation  
representation.items [i] ->  
{representation\_item  
representation\_item.name = 'standard point'}  
representation\_item =>  
geometric\_representation\_item =>  
point =>  
cartesian\_point

### 5.1.9.43.3 pmi\_record

AIM element: document.id

Source: 41

Reference path: piping\_component\_definition <=  
product\_definition  
document\_item = product\_definition  
document\_item <=  
applied\_document\_reference.items[i]  
applied\_document\_reference <=  
document\_reference  
document\_reference.assigned\_document ->  
{document  
document.kind ->  
document\_type  
document\_type.product\_data\_type = 'pmi record'}  
document  
document.id

### 5.1.9.43.4 mill\_sheet\_number

AIM element: document.id

Source: 41

Reference path:     piping\_component\_definition <=  
                           product\_definition  
                           document\_item = product\_definition  
                           document\_item <=  
                           applied\_document\_reference.items[i]  
                           applied\_document\_reference <=  
                           document\_reference  
                           document\_reference.assigned\_document ->  
                           {document  
                           document.kind ->  
                           document\_type  
                           document\_type.product\_data\_type = 'mill sheet'}  
                           document  
                           document.id

### 5.1.9.43.5     piping\_component to family\_definition

AIM element:        IDENTICAL MAPPING

### 5.1.9.44     Piping\_size\_description

#1: The attributes are for the definition of a family of piping components.

#2: The attributes are for the individual piping component.

AIM element:        #1: (shape\_dimension\_representation)  
                           #2: (representation)

Source:             43, 47

Reference path:     {(shape\_dimension\_representation <=  
                           shape\_representation <=  
                           representation)  
                           (representation)  
                           document\_item = representation  
                           document\_item <=  
                           applied\_document\_reference.items[i]  
                           applied\_document\_reference <=  
                           document\_reference  
                           document\_reference.assigned\_document ->  
                           document  
                           document.kind ->  
                           document\_type  
                           document\_type.product\_data\_type = 'dimensional standard'}  
                           #1: ({(shape\_dimension\_representation <=  
                           shape\_representation <=  
                           {representation  
                           representation.name = 'piping component dimensions'}})  
                           ({representation  
                           representation.name = 'piping component size'}})  
                           representation <=  
                           property\_definition\_representation.used\_representation  
                           property\_definition\_representation

```

property_definition_representation.definition ->
(represented_definition
represented_definition = property_definition
{property_definition =>
product_definition_shape}
property_definition
property_definition.definition ->
characterized_definition
characterized_definition = characterized_product_definition
characterized_product_definition
characterized_product_definition = product_definition
product_definition =>
piping_component_definition)(represented_definition
represented_definition = shape_aspect
shape_aspect =>
plant_item_connector)))
#2: ([[representation
representation.name = 'piping component class size']
[representation <-
property_definition_representation.used_representation
property_definition_representation
property_definition_representation.definition ->
represented_definition
represented_definition = property_definition
property_definition
property_definition.definition ->
characterized_definition
characterized_definition = characterized_object
characterized_object =>
piping_component_class]])

```

#### 5.1.9.44.1 dimensional\_standard

#1: The attributes are for the definition of a family of piping components.

#2: The attributes are for the individual piping component.

AIM element: document

Source: 41

Rules: subtype\_mandatory\_shape\_representation

Reference path: #1: (shape\_dimension\_representation <=  
shape\_representation <=  
representation)  
#2: (representation)  
document\_item = representation  
document\_item <=  
applied\_document\_reference.items[i]  
applied\_document\_reference <=  
document\_reference  
document\_reference.assigned\_document ->  
document

```
{document.kind ->
document_type
document_type.product_data_type = 'dimensional standard'}
```

### 5.1.9.44.2 ovality\_allowance

#1: The attributes are for the definition of a family of piping components.

#2: The attributes are for the individual piping component.

AIM element: [measure\_with\_unit.value\_component]  
[measure\_with\_unit.unit\_component]

Source: 41

Rules: subtype\_mandatory\_shape\_representation

Reference path: #1: (shape\_dimension\_representation <=  
shape\_representation <=  
representation)  
#2: (representation)  
representation.items[i] ->  
{representation\_item  
(representation\_item.name = 'ovality upper limit')  
(representation\_item.name = 'ovality lower limit')}  
representation\_item =>  
measure\_representation\_item <=  
{measure\_with\_unit =>  
length\_measure\_with\_unit}  
measure\_with\_unit  
[measure\_with\_unit.value\_component]  
[measure\_with\_unit.unit\_component]

### 5.1.9.45 Piping\_spool

AIM element: piping\_spool\_definition

Source: 227

Rules: dependent\_instantiable\_product\_context  
product\_context\_discipline\_type\_constraint  
value\_for\_application\_context

Reference path: piping\_spool\_definition <=  
product\_definition  
{product\_definition  
product\_definition.formation ->  
product\_definition\_formation  
product\_definition\_formation.of\_product ->  
product  
product.frame\_of\_reference[i] ->  
product\_context<=  
application\_context\_element

```
application_context_element.name = 'plant item'}
```

### 5.1.9.45.1 tag\_number

AIM element: product.id

Source: 41

Reference path: piping\_spool\_definition <=  
product\_definition  
product\_definition.formation ->  
product\_definition\_formation  
product\_definition\_formation.of\_product ->  
product  
product.id

### 5.1.9.45.2 piping\_type

AIM element: group.name

Source: 41

Reference path: piping\_spool\_definition <=  
product\_definition  
classification\_item = product\_definition  
classification\_item <=  
applied\_classification\_assignment.items[i]  
applied\_classification\_assignment <=  
{classification\_assignment  
classification\_assignment.role ->  
group\_role  
group\_role.name = 'piping type'}  
classification\_assignment  
classification\_assignment.assigned\_classification ->  
group  
group.name

### 5.1.9.45.3 temporary\_flag

AIM element: application\_context.application

Source: 41

Rules: dependent\_instantiable\_product\_context  
product\_context\_discipline\_type\_constraint  
value\_for\_application\_context

Reference path: piping\_spool\_definition <=  
product\_definition  
product\_definition.formation ->  
product\_definition\_formation  
product\_definition\_formation.of\_product ->  
product.frame\_of\_reference[i] ->

```

product_context <=
application_context_element
application_context_element.frame_of_reference ->
application_context
application_context.application
{(application_context.application = 'temporary piece')}
(application_context.application = 'permanent piece')

```

#### 5.1.9.46 Piping\_support

AIM element: product

Source: 41

Rules: dependent\_instantiable\_product\_context  
product\_context\_discipline\_type\_constraint  
value\_for\_application\_context

Reference path: {[product  
classification\_item = product  
classification\_item <-  
applied\_classification\_assignment.items[i]  
applied\_classification\_assignment <=  
classification\_assignment  
classification\_assignment.assigned\_classification ->  
[group  
group.name = 'piping support']  
[group  
group\_relationship.related\_group  
group\_relationship  
{group\_relationship.name = 'usage classification'}  
group\_relationship.relate\_group ->  
group  
group.name = 'support component']]  
[product  
product.frame\_of\_reference[i] ->  
product\_context <=  
application\_context\_element  
application\_context\_element.name = 'plant item']]}

##### 5.1.9.46.1 orientation

AIM element: axis2\_placement\_3d.ref\_direction

Source: 42

Reference path: product  
product\_definition\_formation.of\_product  
product\_definition\_formation  
product\_definition.formation  
product\_definition  
characterized\_product\_definition = product\_definition  
characterized\_product\_definition

```

characterized_definition = characterized_product_definition
characterized_definition <-
property_definition.definition
property_definition =>
product_definition_shape <-
shape_aspect.of_shape
{shape_aspect.description = 'location point'}
shape_aspect
represented_definition = shape_aspect
represented_definition <-
property_definition_representation.definition
property_definition_representation
property_definition_representation.used_representation ->
representation
representation.items[i] ->
{representation_item
representation_item.name = 'support orientation'}
representation_item =>
geometric_representation_item =>
placement =>
axis2_placement_3d
axis2_placement_3d.ref_direction

```

### 5.1.9.46.2 location\_point

AIM element: placement.location

Source: 42

Reference path:

```

product
product_definition_formation.of_product
product_definition_formation
product_definition.formation
product_definition
characterized_product_definition = product_definition
characterized_product_definition
characterized_definition = characterized_product_definition
characterized_definition <-
property_definition.definition
property_definition =>
product_definition_shape <-
shape_aspect.of_shape
{shape_aspect.description = 'location point'}
shape_aspect
represented_definition = shape_aspect
represented_definition <-
property_definition_representation.definition
property_definition_representation
property_definition_representation.used_representation ->
representation
representation.items[i] ->
{representation_item
representation_item.name = 'support location'}
representation_item =>

```

```

geometric_representation_item =>
  placement
  placement.location

```

### 5.1.9.46.3 end\_1\_connector

AIM element: plant\_item\_connector

Source: 227

Reference path:

```

product
product_definition_formation.of_product
product_definition_formation
product_definition.formation
product_definition
characterized_product_definition = product_definition
characterized_product_definition
characterized_definition = characterized_product_definition
characterized_definition <-
  property_definition.definition
property_definition =>
product_definition_shape <-
  shape_aspect.of_shape
{ shape_aspect
  shape_aspect.description = 'end 1' }
shape_aspect =>
plant_item_connector

```

### 5.1.9.47 Plate

#1: The attributes are for the individual piping component.

#2: The attributes are for the definition of a family of piping components.

AIM element: #1: (piping\_component\_definition)  
#2: (piping\_component\_class)

Source: 227

Rules:

```

dependent_instantiable_product_context
product_context_discipline_type_constraint
value_for_application_context

```

Reference path:

```

#1: (piping_component_definition <=
  product_definition
  { piping_component_definition
    classification_item = piping_component_definition
    classification_item <-
      applied_classification_assignment.items[i]
    applied_classification_assignment <=
      classification_assignment
    classification_assignment.assigned_classification ->
      [group =>

```

```

pipe_closure_fitting_class]
[group
group.name = 'plate']]
{product_definition
product_definition.formation ->
product_definition_formation
product_definition_formation.of_product ->
[product
classification_item = product
classification_item <-
applied_classification_assignment.items[i]
applied_classification_assignment <=
{classification_assignment
classification_assignment.role ->
group_role
group_role.name = 'plant item type'}
classification_assignment
classification_assignment.assigned_classification ->
(group)
(group <-
group_relationship.related_group
group_relationship
group_relationship.relying_group ->
group)
group.name = 'plate'}
[product
product.frame_of_reference[i] ->
product_context<=
application_context_element
application_context_element.name = 'plant item']})
#2: (piping_component_class <=
[characterized_object]
[group])
{[group =>
pipe_closure_fitting_class]
[(group)
(group <-
group_relationship.related_group
group_relationship
group_relationship.relying_group ->
group)
group.name = 'plate']]

```

### 5.1.9.47.1 thickness

#1: The attributes are for the individual piping component.

#2: The attributes are for the definition of a family of piping components.

AIM element:       [measure\_with\_unit.value\_component]  
                   [measure\_with\_unit.unit\_component]

Source:            41

Rules:                subtype\_exclusive\_characterized\_object  
                          subtype\_mandatory\_shape\_representation

Reference path:    #1: (piping\_component\_definition <=  
                          product\_definition  
                          characterized\_product\_definition = product\_definition  
                          characterized\_product\_definition  
                          characterized\_definition = characterized\_product\_definition  
                          characterized\_definition <=  
                          property\_definition.definition  
                          property\_definition =>  
                          product\_definition\_shape <=  
                          shape\_aspect.of\_shape  
                          [shape\_aspect <=  
                          shape\_aspect\_relationship.relating\_shape\_aspect]  
                          [shape\_aspect <=  
                          shape\_aspect\_relationship.related\_shape\_aspect]  
                          shape\_aspect\_relationship =>  
                          dimensional\_location  
                          dimensional\_characteristic = dimensional\_location  
                          dimensional\_characteristic <=  
                          dimensional\_characteristic\_representation.dimension  
                          dimensional\_characteristic\_representation  
                          dimensional\_characteristic\_representation.representation ->  
                          shape\_dimension\_representation <=  
                          shape\_representation <=  
                          {representation  
                          representation.name = 'pipe closure fitting dimensional shape'}  
                          representation  
                          representation.items[i] ->  
                          {representation\_item  
                          representation\_item.name = 'thickness'})  
                          #2: (piping\_component\_class <=  
                          characterized\_object  
                          characterized\_definition = characterized\_object  
                          characterized\_definition <=  
                          property\_definition.definition  
                          property\_definition  
                          represented\_definition = property\_definition  
                          represented\_definition <=  
                          property\_definition\_representation.definition  
                          property\_definition\_representation  
                          property\_definition\_representation.used\_representation ->  
                          {representation  
                          representation.name = 'pipe closure fitting class dimensions'}  
                          representation  
                          (representation.items[i] ->  
                          {representation\_item  
                          (representation\_item.name = 'maximum thickness')  
                          (representation\_item.name = 'minimum thickness'}})  
                          ([representation.items[i] ->  
                          {representation\_item  
                          representation\_item.name = 'maximum thickness'}}]  
                          [representation.items[i] ->

```

{representation_item
representation_item.name = 'minimum thickness'}}))
representation_item =>
measure_representation_item <=
{measure_with_unit =>
length_measure_with_unit}
measure_with_unit
[measure_with_unit.value_component]
[measure_with_unit.unit_component]

```

### 5.1.9.48 Plug

#1: The attributes are for the individual piping component.

#2: The attributes are for the definition of a family of piping components.

AIM element: #1: (piping\_component\_definition)  
#2: (piping\_component\_class)

Source: 227

Rules: dependent\_instantiable\_product\_context  
product\_context\_discipline\_type\_constraint  
value\_for\_application\_context

Reference path: #1: (piping\_component\_definition <= product\_definition  
{piping\_component\_definition  
classification\_item = piping\_component\_definition  
classification\_item <-  
applied\_classification\_assignment.items[i]  
applied\_classification\_assignment <= classification\_assignment  
classification\_assignment.assigned\_classification ->  
[group =>  
pipe\_closure\_fitting\_class]  
[group  
group.name = 'plug']}  
{product\_definition  
product\_definition.formation ->  
product\_definition\_formation  
product\_definition\_formation.of\_product ->  
[product  
classification\_item = product  
classification\_item <-  
applied\_classification\_assignment.items[i]  
applied\_classification\_assignment <= {classification\_assignment  
classification\_assignment.role ->  
group\_role  
group\_role.name = 'plant item type'}  
classification\_assignment  
classification\_assignment.assigned\_classification ->  
(group)

```

(group <-
group_relationship.related_group
group_relationship
group_relationship.relying_group ->
group)
group.name = ' plug' }
[product
product.frame_of_reference[i] ->
product_context<=
application_context_element
application_context_element.name = 'plant item']]
#2: (piping_component_class <=
[characterized_object]
[group])
{[group =>
pipe_closure_fitting_class]
[(group)
(group <-
group_relationship.related_group
group_relationship
group_relationship.relying_group ->
group)
group.name = ' plug']]

```

### 5.1.9.48.1 height

#1: The attributes are for the individual piping component.

#2: The attributes are for the definition of a family of piping components.

AIM element: [measure\_with\_unit.value\_component]  
[measure\_with\_unit.unit\_component]

Source: 41

Rules: subtype\_exclusive\_characterized\_object  
subtype\_mandatory\_shape\_representation

Reference path: #1: (piping\_component\_definition <=
product\_definition
characterized\_product\_definition = product\_definition
characterized\_product\_definition
characterized\_definition = characterized\_product\_definition
characterized\_definition <-
property\_definition.definition
property\_definition =>
product\_definition\_shape <-
shape\_aspect.of\_shape
[shape\_aspect <-
shape\_aspect\_relationship.relying\_shape\_aspect]
[shape\_aspect <-
shape\_aspect\_relationship.related\_shape\_aspect]
shape\_aspect\_relationship =>
dimensional\_location

```

dimensional_characteristic = dimensional_location
dimensional_characteristic <-
dimensional_characteristic_representation.dimension
dimensional_characteristic_representation
dimensional_characteristic_representation.representation ->
shape_dimension_representation <=
shape_representation <=
{representation
representation.name = 'pipe closure fitting dimensional shape'}
representation
representation.items[i] ->
{representation_item
representation_item.name = 'height'})
#2: (piping_component_class <=
characterized_object
characterized_definition = characterized_object
characterized_definition <-
property_definition.definition
property_definition
represented_definition = property_definition
represented_definition <-
property_definition_representation.definition
property_definition_representation
property_definition_representation.used_representation ->
{representation
representation.name = 'pipe closure fitting class dimensions'}
representation
(representation.items[i] ->
{representation_item
(representation_item.name = 'maximum height')
(representation_item.name = 'minimum height')})
([representation.items[i] ->
{representation_item
representation_item.name = 'maximum height'}]
[representation.items[i] ->
{representation_item
representation_item.name = 'minimum height'}]))
representation_item =>
measure_representation_item <=
{measure_with_unit =>
length_measure_with_unit}
measure_with_unit
[measure_with_unit.value_component]
[measure_with_unit.unit_component]

```

### 5.1.9.49 Pressure\_class

#1: The attributes are for an individual piping component.

#2: The attributes are for the definition of a family of piping components.

AIM element:        representation

Source: 43

Reference path: #1: ({[representation  
representation.name = 'piping component size']  
[representation <-  
property\_definition\_representation.used\_representation  
property\_definition\_representation  
property\_definition\_representation.definition ->  
(represented\_definition  
represented\_definition = property\_definition  
property\_definition  
property\_definition.definition ->  
characterized\_definition  
characterized\_definition = characterized\_product\_definition  
characterized\_product\_definition  
characterized\_product\_definition = product\_definition  
product\_definition =>  
piping\_component\_definition)  
(represented\_definition  
represented\_definition = shape\_aspect  
shape\_aspect =>  
plant\_item\_connector))])  
#2: ({[representation  
representation.name = 'piping component class size']  
[representation <-  
property\_definition\_representation.used\_representation  
property\_definition\_representation  
property\_definition\_representation.definition ->  
represented\_definition  
represented\_definition = property\_definition  
property\_definition  
property\_definition.definition ->  
characterized\_definition  
characterized\_definition = characterized\_object  
characterized\_object =>  
piping\_component\_class])])

### 5.1.9.49.1 nominal\_size

#1: The attributes are for an individual piping component.

#2: The attributes are for the definition of a family of piping components.

AIM element: [measure\_with\_unit.value\_component]  
[measure\_with\_unit.unit\_component]

Source: 41

Reference path: representation  
#1: ({representation  
representation.name = 'piping component size'}  
representation.items[i] ->  
{representation\_item  
representation\_item.name = 'nominal size'})

```

#2: ({representation
representation.name = 'piping component class size'}
(representation.items[i] ->
{representation_item
(representation_item.name = 'maximum nominal size')
(representation_item.name = 'minimum nominal size'))}
([representation.items[i] ->
{representation_item
representation_item.name = 'maximum nominal size'}]
[representation.items[i] ->
{representation_item
representation_item.name = 'minimum nominal size'}]))
representation_item =>
measure_representation_item <=
measure_with_unit
[measure_with_unit.value_component]
[measure_with_unit.unit_component]

```

### 5.1.9.49.2 pressure\_rating

#1: The attributes are for an individual piping component.

#2: The attributes are for the definition of a family of piping components.

AIM element: [measure\_with\_unit.value\_component]  
[measure\_with\_unit.unit\_component]

Source: 41

Reference path: representation  
#1: ({representation  
representation.name = 'piping component size'}  
representation.items[i] ->  
{representation\_item  
representation\_item.name = 'pressure rating'})  
#2: ({representation  
representation.name = 'piping component class size'}  
(representation.items[i] ->  
{representation\_item  
(representation\_item.name = 'maximum pressure rating')  
(representation\_item.name = 'minimum pressure rating'))}  
([representation.items[i] ->  
{representation\_item  
representation\_item.name = 'maximum pressure rating'}]  
[representation.items[i] ->  
{representation\_item  
representation\_item.name = 'minimum pressure rating'}]))  
representation\_item =>  
measure\_representation\_item <=  
measure\_with\_unit  
[{measure\_with\_unit.value\_component ->  
measure\_value  
measure\_value = ratio\_measure}  
measure\_with\_unit.value\_component]

```
[{ measure_with_unit.unit_component ->
  unit
  unit = derived_unit }
measure_with_unit.unit_component]
```

### 5.1.9.50 Reducer

#1: The attributes are for an individual piping component.

#2: The attributes are for the definition of a family of piping components.

AIM element:       #1: (piping\_component\_definition)  
                      #2: (piping\_component\_class)

Source:             227

Rules:              dependent\_instantiable\_product\_context  
                      product\_context\_discipline\_type\_constraint  
                      value\_for\_application\_context

Reference path:    #1: (piping\_component\_definition <=  
                      product\_definition  
                      {product\_definition  
                      product\_definition.formation ->  
                      product\_definition\_formation  
                      product\_definition\_formation.of\_product ->  
                      [product  
                      classification\_item = product  
                      classification\_item <=  
                      applied\_classification\_assignment.items[i]  
                      applied\_classification\_assignment <=  
                      classification\_assignment  
                      classification\_assignment.assigned\_classification ->  
                      (group)  
                      (group <=  
                      group\_relationship.related\_group  
                      group\_relationship  
                      group\_relationship.relate\_group ->  
                      group)  
                      group.name = 'reducer']  
                      [product  
                      product.frame\_of\_reference[i] ->  
                      product\_context<=  
                      application\_context\_element  
                      application\_context\_element.name = 'plant item']})  
                      #2: (piping\_component\_class <=  
                      [characterized\_object]  
                      [group])

#### 5.1.9.50.1 end\_1\_connector

AIM element:       plant\_item\_connector

Source: 227

Reference path: piping\_component\_definition <=  
product\_definition  
characterized\_product\_definition = product\_definition  
characterized\_product\_definition  
characterized\_definition = characterized\_product\_definition  
characterized\_definition <=  
property\_definition.definition  
property\_definition =>  
product\_definition\_shape <=  
shape\_aspect.of\_shape  
{shape\_aspect  
shape\_aspect.description = 'end 1'}  
shape\_aspect =>  
plant\_item\_connector

### 5.1.9.50.2 end\_2\_connector

AIM element: plant\_item\_connector

Source: 227

Reference path: piping\_component\_definition <=  
product\_definition  
characterized\_product\_definition = product\_definition  
characterized\_product\_definition  
characterized\_definition = characterized\_product\_definition  
characterized\_definition <=  
property\_definition.definition  
property\_definition =>  
product\_definition\_shape <=  
shape\_aspect.of\_shape  
{shape\_aspect  
shape\_aspect.description = 'end 2'}  
shape\_aspect =>  
plant\_item\_connector

### 5.1.9.50.3 end\_to\_end\_length

#1: The attributes are for an individual piping component.

#2: The attributes are for the definition of a family of piping components.

AIM element: [measure\_with\_unit.value\_component]  
[measure\_with\_unit.unit\_component]

Source: 41

Rules: subtype\_exclusive\_characterized\_object  
subtype\_mandatory\_shape\_representation

Reference path: #1: (piping\_component\_definition <=

```

product_definition
characterized_product_definition = product_definition
characterized_product_definition
characterized_definition = characterized_product_definition
characterized_definition <-
property_definition.definition
property_definition =>
product_definition_shape <-
shape_aspect.of_shape
[[[shape_aspect =>
plant_item_connector]
[shape_aspect
shape_aspect.description = 'end 1']]
shape_aspect <-
shape_aspect_relationship.relatng_shape_aspect]
[[[shape_aspect =>
plant_item_connector]
[shape_aspect
shape_aspect.description = 'end 2']]
shape_aspect <-
shape_aspect_relationship.related_shape_aspect]
shape_aspect_relationship =>
dimensional_location
dimensional_characteristic = dimensional_location
dimensional_characteristic <-
dimensional_characteristic_representation.dimension
dimensional_characteristic_representation
dimensional_characteristic_representation.representation ->
shape_dimension_representation <=
shape_representation <=
{representation
representation.name = 'reducer fitting dimensional shape'}
representation
representation.items[i] ->
{representation_item
representation_item.name = 'end to end length'}}
#2: (piping_component_class <=
characterized_object
characterized_definition = characterized_object
characterized_definition <-
property_definition.definition
property_definition
represented_definition = property_definition
represented_definition <-
property_definition_representation.definition
property_definition_representation
property_definition_representation.used_representation ->
{representation
representation.name = 'reducer fitting class dimensions'}
representation
(representation.items[i] ->
{representation_item
(representation_item.name = 'maximum end to end length')
(representation_item.name = 'minimum end to end length'))})

```

```

([representation.items[i] ->
 {representation_item
 representation_item.name = 'maximum end to end length'}]
 [representation.items[i] ->
 {representation_item
 representation_item.name = 'minimum end to end length'}}))
representation_item =>
measure_representation_item <=
 {measure_with_unit =>
 length_measure_with_unit}
measure_with_unit
 [measure_with_unit.value_component]
 [measure_with_unit.unit_component]

```

### 5.1.9.51 Reducing flange

AIM element:      piping\_component\_definition

Source:            227

Rules:            dependent\_instantiable\_product\_context  
                     product\_context\_discipline\_type\_constraint  
                     value\_for\_application\_context

Reference path:    piping\_component\_definition <=
                     product\_definition
                     {piping\_component\_definition
                     classification\_item = piping\_component\_definition
                     classification\_item <-
                     applied\_classification\_assignment.items[i]
                     applied\_classification\_assignment <=
                     classification\_assignment
                     classification\_assignment.assigned\_classification ->
                     [group =>
                     flange\_fitting\_class]
                     [group
                     group.name = 'reducing flange']}
                     {product\_definition
                     product\_definition.formation ->
                     product\_definition\_formation
                     product\_definition\_formation.of\_product ->
                     [product
                     classification\_item = product
                     classification\_item <-
                     applied\_classification\_assignment.items[i]
                     applied\_classification\_assignment <=
                     classification\_assignment
                     classification\_assignment.assigned\_classification ->
                     (group)
                     (group <-
                     group\_relationship.related\_group
                     group\_relationship
                     group\_relationship.relate\_group ->
                     group)

```

group.name = 'flange']
[product
product.frame_of_reference[i] ->
product_context<=
application_context_element
application_context_element.name = 'plant item']]

```

### 5.1.9.52 Reinforcing\_component

AIM element: product

Source: 41

Rules: dependent\_instantiable\_product\_context  
product\_context\_discipline\_type\_constraint  
value\_for\_application\_context

Reference path: {[product  
classification\_item = product  
classification\_item <-  
applied\_classification\_assignment.items[i]  
applied\_classification\_assignment <=  
classification\_assignment  
classification\_assignment.assigned\_classification ->  
[group  
group.name = 'reinforcing component']  
[group  
group\_relationship.related\_group  
group\_relationship  
{group\_relationship.name = 'usage classification'}  
group\_relationship.relate\_group ->  
group  
group.name = 'support component']]  
[product  
product.frame\_of\_reference[i] ->  
product\_context <=  
application\_context\_element  
application\_context\_element.name = 'plant item']]}

#### 5.1.9.52.1 orientation

AIM element: axis2\_placement\_3d.ref\_direction

Source: 42

Reference path: product  
product\_definition\_formation.of\_product  
product\_definition\_formation  
product\_definition.formation  
product\_definition  
characterized\_product\_definition = product\_definition  
characterized\_product\_definition  
characterized\_definition = characterized\_product\_definition

```

characterized_definition <-
property_definition.definition
property_definition =>
product_definition_shape <-
shape_aspect.of_shape
shape_aspect
represented_definition = shape_aspect
represented_definition <-
property_definition_representation.definition
property_definition_representation
property_definition_representation.used_representation ->
representation
representation.items[i] ->
{representation_item
representation_item.name = 'reinforcing orientation'}
representation_item =>
geometric_representation_item =>
placement =>
axis2_placement_3d
axis2_placement_3d.ref_direction

```

### 5.1.9.52.2 location\_point

AIM element: placement.location

Source: 42

Reference path:

```

product
product_definition_formation.of_product
product_definition_formation
product_definition.formation
product_definition
characterized_product_definition = product_definition
characterized_product_definition
characterized_definition = characterized_product_definition
characterized_definition <-
property_definition.definition
property_definition =>
product_definition_shape <-
shape_aspect.of_shape
shape_aspect
represented_definition = shape_aspect
represented_definition <-
property_definition_representation.definition
property_definition_representation
property_definition_representation.used_representation ->
representation
representation.items[i] ->
{representation_item
representation_item.name = 'reinforcing location'}
representation_item =>
geometric_representation_item =>
placement

```

placement.location

### 5.1.9.52.3 end\_1\_connector

AIM element: plant\_item\_connector

Source: 227

Reference path: product  
 product\_definition\_formation.of\_product  
 product\_definition\_formation  
 product\_definition.formation  
 product\_definition  
 characterized\_product\_definition = product\_definition  
 characterized\_product\_definition  
 characterized\_definition = characterized\_product\_definition  
 characterized\_definition <-  
 property\_definition.definition  
 property\_definition =>  
 product\_definition\_shape <-  
 shape\_aspect.of\_shape  
 {shape\_aspect  
 shape\_aspect.description = 'end 1'}  
 shape\_aspect =>  
 plant\_item\_connector

### 5.1.9.53 Reinforcing\_plate

AIM element: reinforcing\_component\_definition

Source: 227

Rules: dependent\_instantiable\_product\_context  
 product\_context\_discipline\_type\_constraint  
 value\_for\_application\_context

Reference path: reinforcing\_component\_definition <=  
 product\_definition  
 {reinforcing\_component\_definition  
 classification\_item = reinforcing\_component\_definition  
 classification\_item <-  
 applied\_classification\_assignment.items[i]  
 applied\_classification\_assignment <=  
 classification\_assignment  
 classification\_assignment.assigned\_classification ->  
 [group =>  
 piping\_support\_fitting\_-class]  
 [group  
 group.name = 'reinforcing plate']}  
 {product\_definition  
 product\_definition.formation ->  
 product\_definition\_formation  
 product\_definition\_formation.of\_product ->

```

[product
classification_item = product
classification_item <-
applied_classification_assignment.items[i]
applied_classification_assignment <=
classification_assignment
classification_assignment.assigned_classification ->
(group)
(group <-
group_relationship.related_group
group_relationship
group_relationship.relate_group ->
group)
group.name = 'reinforcing component']
[product
product.frame_of_reference[i] ->
product_context <=
application_context_element
application_context_element.name = 'plant item']]

```

### 5.1.9.53.1 thickness

AIM element:	[measure_with_unit.value_component] [measure_with_unit.unit_component]
Source:	41
Rules:	subtype_mandatory_shape_representation
Reference path:	<pre> reinforcing_component_definition &lt;= product_definition characterized_product_definition = product_definition characterized_product_definition characterized_definition = characterized_product_definition characterized_definition &lt;- property_definition.definition property_definition =&gt; product_definition_shape &lt;- shape_aspect.of_shape [shape_aspect &lt;- shape_aspect_relationship.relate_shape_aspect] [shape_aspect &lt;- shape_aspect_relationship.related_shape_aspect] shape_aspect_relationship =&gt; dimensional_location dimensional_characteristic = dimensional_location dimensional_characteristic &lt;- dimensional_characteristic_representation.dimensional dimensional_characteristic_representation dimensional_characteristic_representation.representation -&gt; shape_dimension_representation &lt;= shape_representation &lt;= {representation representation.name = 'reinforcing plate dimensional shape'} </pre>

```

representation
representation.items[i] ->
representation_item =>
{representation_item.name = 'thickness'}
measure_representation_item <=
{measure_with_unit =>
length_measure_with_unit}
measure_with_unit
[measure_with_unit.value_component]
[measure_with_unit.unit_component]

```

### 5.1.9.54 Ring\_spacer

#1: The attributes are for an individual piping component.

#2: The attributes are for the definition of a family of piping components.

AIM element: #1: (piping\_component\_definition)  
#2: (piping\_component\_class)

Source: 227

Rules: dependent\_instantiable\_product\_context  
product\_context\_discipline\_type\_constraint  
value\_for\_application\_context

Reference path: #1: (piping\_component\_definition <= product\_definition  
{piping\_component\_definition  
classification\_item = piping\_component\_definition  
classification\_item <-  
applied\_classification\_assignment.items[i]  
applied\_classification\_assignment <= classification\_assignment  
classification\_assignment.assigned\_classification ->  
[group =>  
spacer\_fitting\_class]  
[group  
group.name = 'ring spacer']}  
{product\_definition  
product\_definition.formation ->  
product\_definition\_formation  
product\_definition\_formation.of\_product ->  
[product  
classification\_item = product  
classification\_item <-  
applied\_classification\_assignment.items[i]  
applied\_classification\_assignment <= classification\_assignment  
classification\_assignment.assigned\_classification ->  
(group)  
(group <-  
group\_relationship.related\_group

```

group_relationship
group_relationship.relatng_group ->
group)
group.name = 'spacer']
[product
product.frame_of_reference[i] ->
product_context<=
application_context_element
application_context_element.name = 'plant item']})
#2: (piping_component_class <=
[characterized_object]
[group])

```

### 5.1.9.54.1 inside\_diameter

#1: The attributes are for an individual piping component.

#2: The attributes are for the definition of a family of piping components.

AIM element: [measure\_with\_unit.value\_component]  
[measure\_with\_unit.unit\_component]

Source: 41

Rules: subtype\_exclusive\_characterized\_object  
subtype\_mandatory\_shape\_representation

Reference path: #1: (piping\_component\_definition <=
product\_definition
characterized\_product\_definition = product\_definition
characterized\_product\_definition
characterized\_definition = characterized\_product\_definition
characterized\_definition <-
property\_definition.definition
property\_definition =>
product\_definition\_shape <-
shape\_aspect.of\_shape
shape\_aspect <-
dimensional\_size.applies\_to
dimensional\_size
dimensional\_characteristic = dimensional\_size
dimensional\_characteristic <-
dimensional\_characteristic\_representation.dimension
dimensional\_characteristic\_representation
dimensional\_characteristic\_representation.representation ->
shape\_dimension\_representation <=
shape\_representation <=
{representation
representation.name = 'spacer fitting dimensional shape'}
representation
representation.items[i] ->
{representation\_item
representation\_item.name = 'inside diameter'})
#2: (piping\_component\_class <=

```

characterized_object
characterized_definition = characterized_object
characterized_definition <-
property_definition.definition
property_definition
represented_definition = property_definition
represented_definition <-
property_definition_representation.definition
property_definition_representation
property_definition_representation.used_representation ->
{representation
representation.name = 'spacer fitting class dimensions'}
representation
(representation.items[i] ->
{representation_item
(representation_item.name = 'maximum inside diameter')
(representation_item.name = 'minimum inside diameter')}})
([representation.items[i] ->
{representation_item
representation_item.name = 'maximum inside diameter'}]
[representation.items[i] ->
{representation_item
representation_item.name = 'minimum inside diameter'}}])
representation_item =>
measure_representation_item <=
{measure_with_unit =>
length_measure_with_unit}
measure_with_unit
[measure_with_unit.value_component]
[measure_with_unit.unit_component]

```

### 5.1.9.55 Schedule

#1: The attributes are for an individual piping component.

#2: The attributes are for the definition of a family of piping components.

AIM element: representation

Source: 43

Reference path: {representation  
document\_item = representation  
document\_item <-  
applied\_document\_reference.items[i]  
applied\_document\_reference <=  
document\_reference  
document\_reference.assigned\_document ->  
document <-  
document\_usage\_constraint.source  
document\_usage\_constraint  
(document\_usage\_constraint.subject\_element = 'pipe schedule')  
(document\_usage\_constraint.subject\_element = 'connector schedule')}

#1: ({[representation

```

representation.name = 'piping component size']
[representation <-
property_definition_representation.used_representation
property_definition_representation
property_definition_representation.definition ->
(represented_definition
represented_definition = property_definition
property_definition
property_definition.definition ->
characterized_definition
characterized_definition = characterized_product_definition
characterized_product_definition
characterized_product_definition = product_definition
product_definition =>
piping_component_definition)
(represented_definition
represented_definition = shape_aspect
shape_aspect =>
plant_item_connector)))]))
#2: ({[representation
representation.name = 'piping component class size']
[representation <-
property_definition_representation.used_representation
property_definition_representation
property_definition_representation.definition ->
represented_definition
represented_definition = property_definition
property_definition
property_definition.definition ->
characterized_definition
characterized_definition = characterized_object
characterized_object =>
piping_component_class]})

```

### 5.1.9.55.1 nominal\_size

#1: The attributes are for an individual piping component.

#2: The attributes are for the definition of a family of piping components.

AIM element: [measure\_with\_unit.value\_component]  
[measure\_with\_unit.unit\_component]

Source: 41

Reference path: representation  
#1: ({representation  
representation.name = 'piping component size'  
representation.items[i] ->  
{representation\_item  
representation\_item.name = 'nominal size'}})  
#2: ({representation

```

representation.name = 'piping component class size'}
(representation.items[i] ->
{representation_item
(representation_item.name = 'maximum nominal size')
(representation_item.name = 'minimum nominal size'}})
([representation.items[i] ->
{representation_item
representation_item.name = 'maximum nominal size'}}]
[representation.items[i] ->
{representation_item
representation_item.name = 'minimum nominal size'}}])
representation_item =>
measure_representation_item <=
measure_with_unit
[measure_with_unit.value_component]
[measure_with_unit.unit_component]

```

### 5.1.9.55.2 pipe\_schedule

AIM element: document\_usage\_constraint.subject\_element\_value

Source: 41

Reference path:

```

representation
document_item = representation
document_item <-
applied_document_reference.items[i]
applied_document_reference <=
document_reference
document_reference.assigned_document ->
document <-
document_usage_constraint.source
document_usage_constraint
document_usage_constraint.subject_element_value

```

### 5.1.9.56 Shoe

AIM element: piping\_support\_definition

Source: 227

Rules:

```

dependent_instantiable_product_context
product_context_discipline_type_constraint
value_for_application_context

```

Reference path:

```

piping_support_definition <=
product_definition
{piping_support_definition
classification_item = piping_support_definition
classification_item <-
applied_classification_assignment.items[i]
applied_classification_assignment <=
classification_assignment

```

```

classification_assignment.assigned_classification ->
[group =>
piping_support_fitting_-class]
[group
group.name = 'shoe']]
{product_definition
product_definition.formation ->
product_definition_formation
product_definition_formation.of_product ->
[product
classification_item = product
classification_item <-
applied_classification_assignment.items[i]
applied_classification_assignment <=
classification_assignment
classification_assignment.assigned_classification ->
(group)
(group <-
group_relationship.related_group
group_relationship
group_relationship.relying_group ->
group)
group.name = 'piping support']
[product
product.frame_of_reference[i] ->
product_context <=
application_context_element
application_context_element.name = 'plant item']))

```

### 5.1.9.56.1 length

AIM element:	[measure_with_unit.value_component] [measure_with_unit.unit_component]
Source:	41
Rules:	subtype_mandatory_shape_representation
Reference path:	<pre> piping_support_definition &lt;= product_definition characterized_product_definition = product_definition characterized_product_definition characterized_definition = characterized_product_definition characterized_definition &lt;- property_definition.definition property_definition =&gt; product_definition_shape &lt;- shape_aspect.of_shape [shape_aspect &lt;- shape_aspect_relationship.relying_shape_aspect] [shape_aspect &lt;- shape_aspect_relationship.related_shape_aspect] shape_aspect_relationship =&gt; dimensional_location </pre>

```

dimensional_characteristic = dimensional_location
dimensional_characteristic <-
dimensional_characteristic_representation.dimension
dimensional_characteristic_representation
dimensional_characteristic_representation.representation ->
shape_dimension_representation <=
shape_representation <=
{representation
representation.name = 'shoe dimensional shape'}
representation
representation.items[i] ->
representation_item =>
{representation_item.name = 'length'}
measure_representation_item <=
{measure_with_unit =>
length_measure_with_unit}
measure_with_unit
[measure_with_unit.value_component]
[measure_with_unit.unit_component]

```

### 5.1.9.57 Slip\_on\_flange

#1: The attributes are for an individual piping component.

#2: The attributes are for the definition of a family of piping components.

AIM element: #1: (piping\_component\_definition)  
#2: (piping\_component\_class)

Source: 227

Rules: dependent\_instantiable\_product\_context  
product\_context\_discipline\_type\_constraint  
value\_for\_application\_context

Reference path: #1: (piping\_component\_definition <=  
product\_definition  
{piping\_component\_definition  
classification\_item = piping\_component\_definition  
classification\_item <-  
applied\_classification\_assignment.items[i]  
applied\_classification\_assignment <=  
classification\_assignment  
classification\_assignment.assigned\_classification ->  
[group =>  
flange\_fitting\_neck\_type\_class]  
[group  
group.name = 'slip on flange']}  
{product\_definition  
product\_definition.formation ->  
product\_definition\_formation  
product\_definition\_formation.of\_product ->  
[product  
classification\_item = product

```

classification_item <-
applied_classification_assignment.items[i]
applied_classification_assignment <=
classification_assignment
classification_assignment.assigned_classification ->
(group)
(group <-
group_relationship.related_group
group_relationship
group_relationship.relying_group ->
group)
group.name = 'flange']
[product
product.frame_of_reference[i] ->
product_context<=
application_context_element
application_context_element.name = 'plant item']]
#2: (piping_component_class <=
[characterized_object]
[group])

```

### 5.1.9.57.1 stand\_off

#1: The attributes are for an individual piping component.

#2: The attributes are for the definition of a family of piping components.

AIM element: [measure\_with\_unit.value\_component]  
[measure\_with\_unit.unit\_component]

Source: 41

Rules: subtype\_exclusive\_characterized\_object  
subtype\_mandatory\_shape\_representation

Reference path: #1: (piping\_component\_definition <=
product\_definition
characterized\_product\_definition = product\_definition
characterized\_product\_definition
characterized\_definition = characterized\_product\_definition
characterized\_definition <-
property\_definition.definition
property\_definition =>
product\_definition\_shape <-
shape\_aspect.of\_shape
[{shape\_aspect
shape\_aspect.name = 'flange face'}
shape\_aspect <-
shape\_aspect\_relationship.relying\_shape\_aspect]
[{shape\_aspect
shape\_aspect.name = 'pipe end'}
shape\_aspect <-
shape\_aspect\_relationship.related\_shape\_aspect]
shape\_aspect\_relationship =>

```

dimensional_location
dimensional_characteristic = dimensional_location
dimensional_characteristic <-
dimensional_characteristic_representation.dimensional
dimensional_characteristic_representation
dimensional_characteristic_representation.representation ->
shape_dimension_representation <=
shape_representation <=
{representation
representation.name = 'slip on flange fitting dimensional shape'}
representation
representation.items[i] ->
{representation_item
representation_item.name = 'stand off'})
#2: (piping_component_class <=
characterized_object
characterized_definition = characterized_object
characterized_definition <-
property_definition.definition
property_definition
represented_definition = property_definition
represented_definition <-
property_definition_representation.definition
property_definition_representation
property_definition_representation.used_representation ->
{representation
representation.name = 'slip on flange fitting class dimensions'}
representation
(representation.items[i] ->
{representation_item
(representation_item.name = 'maximum stand off')
(representation_item.name = 'minimum stand off')})
([representation.items[i] ->
{representation_item
representation_item.name = 'maximum stand off'}]
[representation.items[i] ->
{representation_item
representation_item.name = 'minimum stand off'}]))
representation_item =>
measure_representation_item <=
{measure_with_unit =>
length_measure_with_unit}
measure_with_unit
[measure_with_unit.value_component]
[measure_with_unit.unit_component]

```

### 5.1.9.58 Slip\_on\_jacket\_flange

#1: The attributes are for an individual piping component.

#2: The attributes are for the definition of a family of piping components.

AIM element: #1: (piping\_component\_definition)

#2: (piping\_component\_class)

Source: 227

Rules: dependent\_instantiable\_product\_context  
product\_context\_discipline\_type\_constraint  
value\_for\_application\_context

Reference path: #1: (piping\_component\_definition <=  
product\_definition  
{piping\_component\_definition  
classification\_item = piping\_component\_definition  
classification\_item <=  
applied\_classification\_assignment.items[i]  
applied\_classification\_assignment <=  
classification\_assignment  
classification\_assignment.assigned\_classification ->  
[group =>  
flange\_fitting\_neck\_type\_class]  
[group  
group.name = 'slip on jacket flange']  
[group <=  
group\_relationship.related\_group  
{group\_relationship  
group\_relationship.name = 'class hierarchy'}  
group\_relationship  
group\_relationship.relate\_group ->  
group  
group.name = 'slip on flange']}  
{product\_definition  
product\_definition.formation ->  
product\_definition\_formation  
product\_definition\_formation.of\_product ->  
[product  
classification\_item = product  
classification\_item <=  
applied\_classification\_assignment.items[i]  
applied\_classification\_assignment <=  
{classification\_assignment  
classification\_assignment.role ->  
group\_role  
group\_role.name = 'plant item type'}  
classification\_assignment  
classification\_assignment.assigned\_classification ->  
(group)  
(group <=  
group\_relationship.related\_group  
group\_relationship  
group\_relationship.relate\_group ->  
group)  
group.name = 'slip on jacket flange']  
[product  
product.frame\_of\_reference[i] ->  
product\_context<=

```

application_context_element
application_context_element.name = 'plant item'])
#2: (piping_component_class <=
[characterized_object]
[group])
{[group =>
flange_fitting_neck_type_class]
[group
group.name = 'slip on jacket flange']
(group)
(group <-
group_relationship.related_group
group_relationship
group_relationship.relate_group ->
group)
group.name = 'slip on jacket flange'}

```

### 5.1.9.58.1 end\_3\_connector

AIM element: plant\_item\_connector

Source: 227

Reference path:

```

piping_component_definition <=
product_definition
characterized_product_definition = product_definition
characterized_product_definition
characterized_definition = characterized_product_definition
characterized_definition <-
property_definition.definition
property_definition =>
product_definition_shape <-
shape_aspect.of_shape
{shape_aspect
shape_aspect.description = 'end 1'}
shape_aspect =>
plant_item_connector

```

### 5.1.9.59 Socket\_weld\_flange

AIM element: piping\_component\_definition

Source: 227

Rules:

```

dependent_instantiable_product_context
product_context_discipline_type_constraint
value_for_application_context

```

Reference path:

```

piping_component_definition <=
product_definition
{piping_component_definition
classification_item = piping_component_definition
classification_item <-

```

```

applied_classification_assignment.items[i]
applied_classification_assignment <=
classification_assignment
classification_assignment.assigned_classification ->
[group =>
flange_fitting_neck_type_class]
[group
group.name = 'socket weld flange']]
{product_definition
product_definition.formation ->
product_definition_formation
product_definition_formation.of_product ->
[product
classification_item = product
classification_item <-
applied_classification_assignment.items[i]
applied_classification_assignment <=
classification_assignment
classification_assignment.assigned_classification ->
(group)
(group <-
group_relationship.related_group
group_relationship
group_relationship.relatng_group ->
group)
group.name = 'flange']
[product
product.frame_of_reference[i] ->
product_context<=
application_context_element
application_context_element.name = 'plant item']]

```

### 5.1.9.60 Spacer

#1: The attributes are for an individual piping component.

#2: The attributes are for the definition of a family of piping components.

AIM element:       #1: (piping\_component\_definition)  
                      #2: (piping\_component\_class)

Source:             227

Rules:              dependent\_instantiable\_product\_context  
                      product\_context\_discipline\_type\_constraint  
                      value\_for\_application\_context

Reference path:     #1: (piping\_component\_definition <=
product\_definition
{product\_definition
product\_definition.formation ->
product\_definition\_formation
product\_definition\_formation.of\_product ->
[product

```

classification_item = product
classification_item <-
applied_classification_assignment.items[i]
applied_classification_assignment <=
classification_assignment
classification_assignment.assigned_classification ->
(group)
(group <-
group_relationship.related_group
group_relationship
group_relationship.relying_group ->
group)
group.name = 'spacer']
[product
product.frame_of_reference[i] ->
product_context<=
application_context_element
application_context_element.name = 'plant item']]
#2: (piping_component_class <=
[characterized_object]
[group])

```

### 5.1.9.60.1 outside\_diameter

#1: The attributes are for an individual piping component.

#2: The attributes are for the definition of a family of piping components.

AIM element: [measure\_with\_unit.value\_component]  
[measure\_with\_unit.unit\_component]

Source: 41

Rules: subtype\_exclusive\_characterized\_object  
subtype\_mandatory\_shape\_representation

Reference path: #1: (piping\_component\_definition <=
product\_definition
characterized\_product\_definition = product\_definition
characterized\_product\_definition
characterized\_definition = characterized\_product\_definition
characterized\_definition <-
property\_definition.definition
property\_definition =>
product\_definition\_shape <-
shape\_aspect.of\_shape
shape\_aspect <-
dimensional\_size.applies\_to
dimensional\_size
dimensional\_characteristic = dimensional\_size
dimensional\_characteristic <-
dimensional\_characteristic\_representation.dimension
dimensional\_characteristic\_representation
dimensional\_characteristic\_representation.representation ->

```

shape_dimension_representation <=
shape_representation <=
{representation
representation.name = 'spacer fitting dimensional shape'}
representation
representation.items[i] ->
{representation_item
representation_item.name = 'outside diameter'}}
#2: (piping_component_class <=
characterized_object
characterized_definition = characterized_object
characterized_definition <-
property_definition.definition
property_definition
represented_definition = property_definition
represented_definition <-
property_definition_representation.definition
property_definition_representation
property_definition_representation.used_representation ->
{representation
representation.name = 'spacer fitting class dimensions'}
representation
(representation.items[i] ->
{representation_item
(representation_item.name = 'maximum outside diameter')
(representation_item.name = 'minimum outside diameter')}}
([representation.items[i] ->
{representation_item
representation_item.name = 'maximum outside diameter'}]
[representation.items[i] ->
{representation_item
representation_item.name = 'minimum outside diameter'}}]))
representation_item =>
measure_representation_item <=
{measure_with_unit =>
length_measure_with_unit}
measure_with_unit
[measure_with_unit.value_component]
[measure_with_unit.unit_component]

```

### 5.1.9.60.2 thickness

#1: The attributes are for an individual piping component.

#2: The attributes are for the definition of a family of piping components.

AIM element: [measure\_with\_unit.value\_component]  
[measure\_with\_unit.unit\_component]

Source: 41

Rules: subtype\_exclusive\_characterized\_object  
subtype\_mandatory\_shape\_representation

```

Reference path:  #1: (piping_component_definition <=
                  product_definition
                  characterized_product_definition = product_definition
                  characterized_product_definition
                  characterized_definition = characterized_product_definition
                  characterized_definition <-
                  property_definition.definition
                  property_definition =>
                  product_definition_shape <-
                  shape_aspect.of_shape
                  [shape_aspect <-
                  shape_aspect_relationship.relating_shape_aspect]
                  [shape_aspect <-
                  shape_aspect_relationship.related_shape_aspect]
                  shape_aspect_relationship =>
                  dimensional_location
                  dimensional_characteristic = dimensional_location
                  dimensional_characteristic <-
                  dimensional_characteristic_representation.dimension
                  dimensional_characteristic_representation
                  dimensional_characteristic_representation.representation ->
                  shape_dimension_representation <=
                  shape_representation <=
                  {representation
                  representation.name = 'spacer fitting dimensional shape'}
                  representation
                  representation.items[i] ->
                  {representation_item
                  representation_item.name = 'thickness'})
                  #2: (piping_component_class <=
                  characterized_object
                  characterized_definition = characterized_object
                  characterized_definition <-
                  property_definition.definition
                  property_definition
                  represented_definition = property_definition
                  represented_definition <-
                  property_definition_representation.definition
                  property_definition_representation
                  property_definition_representation.used_representation ->
                  {representation
                  representation.name = 'spacer fitting class dimensions'}
                  representation
                  (representation.items[i] ->
                  {representation_item
                  (representation_item.name = 'maximum thickness')
                  (representation_item.name = 'minimum thickness')})
                  ([representation.items[i] ->
                  {representation_item
                  representation_item.name = 'maximum thickness'}}
                  [representation.items[i] ->
                  {representation_item
                  representation_item.name = 'minimum thickness'}}]))
representation_item =>

```

```

measure_representation_item <=
{measure_with_unit =>
length_measure_with_unit}
measure_with_unit
[measure_with_unit.value_component]
[measure_with_unit.unit_component]

```

### 5.1.9.61 Specialty\_item

AIM element:      piping\_component\_definition

Source:            227

Rules:             dependent\_instantiable\_product\_context  
product\_context\_discipline\_type\_constraint  
value\_for\_application\_context

Reference path:    piping\_component\_definition <=
product\_definition
{product\_definition
product\_definition.formation ->
product\_definition\_formation
product\_definition\_formation.of\_product ->
product
product.frame\_of\_reference[i] ->
product\_context<=
application\_context\_element
application\_context\_element.name = 'plant item'}

#### 5.1.9.61.1 type

AIM element:      group.name

Source:            41

Reference path:    piping\_component\_definition
classification\_item = piping\_component\_definition
classification\_item <-
applied\_classification\_assignment.items[i]
applied\_classification\_assignment <=
{classification\_assignment
classification\_assignment.role ->
classification\_role
classification\_role.name = 'specialty item type classification'}
classification\_assignment
classification\_assignment.assigned\_classification ->
{group =>
specialty\_item\_class}
group
group.name

**5.1.9.62 Spectacle\_blind**

#1: The attributes are for an individual piping component.

#2: The attributes are for the definition of a family of piping components.

AIM element: #1: (piping\_component\_definition)  
#2: (piping\_component\_class)

Source: 227

Rules: dependent\_instantiable\_product\_context  
product\_context\_discipline\_type\_constraint  
value\_for\_application\_context

Reference path: #1: (piping\_component\_definition <=  
product\_definition  
{piping\_component\_definition  
classification\_item = piping\_component\_definition  
classification\_item <=  
applied\_classification\_assignment.items[i]  
applied\_classification\_assignment <=  
classification\_assignment  
classification\_assignment.assigned\_classification ->  
[group =>  
blank\_fitting\_class]  
[group  
group.name = 'spectacle blind']}  
{product\_definition  
product\_definition.formation ->  
product\_definition\_formation  
product\_definition\_formation.of\_product ->  
[product  
classification\_item = product  
classification\_item <=  
applied\_classification\_assignment.items[i]  
applied\_classification\_assignment <=  
classification\_assignment  
classification\_assignment.assigned\_classification ->  
(group)  
(group <=  
group\_relationship.related\_group  
group\_relationship  
group\_relationship.relating\_group ->  
group)  
group.name = 'blank']  
[product  
product.frame\_of\_reference[i] ->  
product\_context<=  
application\_context\_element  
application\_context\_element.name = 'plant item']})  
#2: (piping\_component\_class <=  
[characterized\_object]

[group])

### 5.1.9.62.1 arm\_width

#1: The attributes are for an individual piping component.

#2: The attributes are for the definition of a family of piping components.

AIM element: [measure\_with\_unit.value\_component]  
[measure\_with\_unit.unit\_component]

Source: 41

Rules: subtype\_exclusive\_characterized\_object  
subtype\_mandatory\_shape\_representation

Reference path: #1: (piping\_component\_definition <=  
product\_definition  
characterized\_product\_definition = product\_definition  
characterized\_product\_definition  
characterized\_definition = characterized\_product\_definition  
characterized\_definition <=  
property\_definition.definition  
property\_definition =>  
product\_definition\_shape <=  
shape\_aspect.of\_shape  
[shape\_aspect <=  
shape\_aspect\_relationship.relating\_shape\_aspect]  
[shape\_aspect <=  
shape\_aspect\_relationship.related\_shape\_aspect]  
shape\_aspect\_relationship =>  
dimensional\_location  
dimensional\_characteristic = dimensional\_location  
dimensional\_characteristic <=  
dimensional\_characteristic\_representation.dimension  
dimensional\_characteristic\_representation  
dimensional\_characteristic\_representation.representation ->  
shape\_dimension\_representation <=  
shape\_representation <=  
{representation  
representation.name = 'blank fitting dimensional shape'}  
representation  
representation.items[i] ->  
{representation\_item  
representation\_item.name = 'arm width'})  
#2: (piping\_component\_class <=  
characterized\_object  
characterized\_definition = characterized\_object  
characterized\_definition <=  
property\_definition.definition  
property\_definition  
represented\_definition = property\_definition  
represented\_definition <=  
property\_definition\_representation.definition

```

property_definition_representation
property_definition_representation.used_representation ->
{representation
representation.name = 'blank fitting class dimensions'}
representation
(representation.items[i] ->
{representation_item
(representation_item.name = 'maximum arm width')
(representation_item.name = 'minimum arm width'}})
([representation.items[i] ->
{representation_item
representation_item.name = 'maximum arm width'}]
[representation.items[i] ->
{representation_item
representation_item.name = 'minimum arm width'}}])
representation_item =>
measure_representation_item <=
{measure_with_unit =>
length_measure_with_unit}
measure_with_unit
[measure_with_unit.value_component]
[measure_with_unit.unit_component]

```

### 5.1.9.62.2 centre\_to\_centre

#1: The attributes are for an individual piping component.

#2: The attributes are for the definition of a family of piping components.

AIM element: [measure\_with\_unit.value\_component]  
[measure\_with\_unit.unit\_component]

Source: 41

Rules: subtype\_exclusive\_characterized\_object  
subtype\_mandatory\_shape\_representation

Reference path: #1: (piping\_component\_definition <=  
product\_definition  
characterized\_product\_definition = product\_definition  
characterized\_product\_definition  
characterized\_definition = characterized\_product\_definition  
characterized\_definition <=  
property\_definition.definition  
property\_definition =>  
product\_definition\_shape <=  
[shape\_aspect.of\_shape  
{shape\_aspect  
shape\_aspect.description = 'centre'}  
shape\_aspect <=  
shape\_aspect\_relationship.relate\_shape\_aspect]  
[shape\_aspect.of\_shape  
{shape\_aspect  
shape\_aspect.description = 'centre'}]

```

shape_aspect <-
shape_aspect_relationship.related_shape_aspect]
shape_aspect_relationship =>
dimensional_location
dimensional_characteristic = dimensional_location
dimensional_characteristic <-
dimensional_characteristic_representation.dimension
dimensional_characteristic_representation
dimensional_characteristic_representation.representation ->
shape_dimension_representation <=
shape_representation <=
{representation
representation.name = 'blank fitting dimensional shape'}
representation
representation.items[i] ->
{representation_item
representation_item.name = 'centre to centre'}}
#2: (piping_component_class <=
characterized_object
characterized_definition = characterized_object
characterized_definition <-
property_definition.definition
property_definition
represented_definition = property_definition
represented_definition <-
property_definition_representation.definition
property_definition_representation
property_definition_representation.used_representation ->
{representation
representation.name = 'blank fitting class dimensions'}
representation
(representation.items[i] ->
{representation_item
(representation_item.name = 'maximum centre to centre')
(representation_item.name = 'minimum centre to centre'}})
([representation.items[i] ->
{representation_item
representation_item.name = 'maximum centre to centre'}]
[representation.items[i] ->
{representation_item
representation_item.name = 'minimum centre to centre'}}]))
representation_item =>
measure_representation_item <=
{measure_with_unit =>
length_measure_with_unit}
measure_with_unit
[measure_with_unit.value_component]
[measure_with_unit.unit_component]

```

### 5.1.9.62.3 inside\_ring\_diameter

#1: The attributes are for an individual piping component.

#2: The attributes are for the definition of a family of piping components.

AIM element: [measure\_with\_unit.value\_component]  
[measure\_with\_unit.unit\_component]

Source: 41

Rules: subtype\_exclusive\_characterized\_object  
subtype\_mandatory\_shape\_representation

Reference path: #1: (piping\_component\_definition <=  
product\_definition  
characterized\_product\_definition = product\_definition  
characterized\_product\_definition  
characterized\_definition = characterized\_product\_definition  
characterized\_definition <=  
property\_definition.definition  
property\_definition =>  
product\_definition\_shape <=  
shape\_aspect.of\_shape  
shape\_aspect <=  
dimensional\_size.applies\_to  
dimensional\_size  
dimensional\_characteristic = dimensional\_size  
dimensional\_characteristic <=  
dimensional\_characteristic\_representation.dimension  
dimensional\_characteristic\_representation  
dimensional\_characteristic\_representation.representation ->  
shape\_dimension\_representation <=  
shape\_representation <=  
{representation  
representation.name = 'blank fitting dimensional shape'}  
representation  
representation.items[i] ->  
{representation\_item  
representation\_item.name = 'inside ring diameter'})  
#2: (piping\_component\_class <=  
characterized\_object  
characterized\_definition = characterized\_object  
characterized\_definition <=  
property\_definition.definition  
property\_definition  
represented\_definition = property\_definition  
represented\_definition <=  
property\_definition\_representation.definition  
property\_definition\_representation  
property\_definition\_representation.used\_representation ->  
{representation  
representation.name = 'blank fitting class dimensions'}  
representation  
(representation.items[i] ->  
{representation\_item  
(representation\_item.name = 'maximum inside ring diameter')  
(representation\_item.name = 'minimum inside ring diameter'))})

```

([representation.items[i] ->
 {representation_item
 representation_item.name = 'maximum inside ring diameter'}]
 [representation.items[i] ->
 {representation_item
 representation_item.name = 'minimum inside ring diameter'}}))
representation_item =>
measure_representation_item <=
 {measure_with_unit =>
 length_measure_with_unit}
measure_with_unit
 [measure_with_unit.value_component]
 [measure_with_unit.unit_component]

```

### 5.1.9.63 Stay

AIM element: reinforcing\_component\_definition

Source: 227

Rules: dependent\_instantiable\_product\_context  
product\_context\_discipline\_type\_constraint  
value\_for\_application\_context

Reference path: reinforcing\_component\_definition <=

```

product_definition
 {reinforcing_component_definition
 classification_item = reinforcing_component_definition
 classification_item <-
 applied_classification_assignment.items[i]
 applied_classification_assignment <=
 classification_assignment
 classification_assignment.assigned_classification ->
 [group =>
 piping_support_fitting_-class]
 [group
 group.name = 'stay']}
 {product_definition
 product_definition.formation ->
 product_definition_formation
 product_definition_formation.of_product ->
 [product
 classification_item = product
 classification_item <-
 applied_classification_assignment.items[i]
 applied_classification_assignment <=
 classification_assignment
 classification_assignment.assigned_classification ->
 (group)
 (group <-
 group_relationship.related_group
 group_relationship
 group_relationship.relate_group ->
 group)

```

```

group.name = 'reinforcing component']
[product
product.frame_of_reference[i] ->
product_context <=
application_context_element
application_context_element.name = 'plant item']]

```

### 5.1.9.63.1 height

AIM element: [measure\_with\_unit.value\_component]  
[measure\_with\_unit.unit\_component]

Source: 41

Rules: subtype\_mandatory\_shape\_representation

Reference path: reinforcing\_component\_definition <=  
product\_definition  
characterized\_product\_definition = product\_definition  
characterized\_product\_definition  
characterized\_definition = characterized\_product\_definition  
characterized\_definition <=  
property\_definition.definition  
property\_definition =>  
product\_definition\_shape <=  
shape\_aspect.of\_shape  
[shape\_aspect <=  
shape\_aspect\_relationship.relate\_shape\_aspect]  
[shape\_aspect <=  
shape\_aspect\_relationship.related\_shape\_aspect]  
shape\_aspect\_relationship =>  
dimensional\_location  
dimensional\_characteristic = dimensional\_location  
dimensional\_characteristic <=  
dimensional\_characteristic\_representation.dimension  
dimensional\_characteristic\_representation  
dimensional\_characteristic\_representation.representation ->  
shape\_dimension\_representation <=  
shape\_representation <=  
{representation  
representation.name = 'stay dimensional shape'}  
representation  
representation.items[i] ->  
representation\_item =>  
{representation\_item.name = 'height'}  
measure\_representation\_item <=  
{measure\_with\_unit =>  
length\_measure\_with\_unit}  
measure\_with\_unit  
[measure\_with\_unit.value\_component]  
[measure\_with\_unit.unit\_component]

### 5.1.9.64 Stopper

AIM element:        piping\_support\_definition

Source:             227

Rules:              dependent\_instantiable\_product\_context  
                       product\_context\_discipline\_type\_constraint  
                       value\_for\_application\_context

Reference path:    piping\_support\_definition <=  
                       product\_definition  
                       {piping\_support\_definition  
                       classification\_item = piping\_support\_definition  
                       classification\_item <=  
                       applied\_classification\_assignment.items[i]  
                       applied\_classification\_assignment <=  
                       classification\_assignment  
                       classification\_assignment.assigned\_classification ->  
                       [group =>  
                       piping\_support\_fitting\_-class]  
                       [group  
                       group.name = 'trunnion']}  
                       {product\_definition  
                       product\_definition.formation ->  
                       product\_definition\_formation  
                       product\_definition\_formation.of\_product ->  
                       [product  
                       classification\_item = product  
                       classification\_item <=  
                       applied\_classification\_assignment.items[i]  
                       applied\_classification\_assignment <=  
                       classification\_assignment  
                       classification\_assignment.assigned\_classification ->  
                       (group)  
                       (group <=  
                       group\_relationship.related\_group  
                       group\_relationship  
                       group\_relationship.relate\_group ->  
                       group)  
                       group.name = 'piping support']  
                       [product  
                       product.frame\_of\_reference[i] ->  
                       product\_context <=  
                       application\_context\_element  
                       application\_context\_element.name = 'plant item']})

#### 5.1.9.64.1 length

AIM element:        [measure\_with\_unit.value\_component]  
                       [measure\_with\_unit.unit\_component]

Source:             41

Rules: subtype\_mandatory\_shape\_representation

Reference path: piping\_support\_definition <=  
product\_definition  
characterized\_product\_definition = product\_definition  
characterized\_product\_definition  
characterized\_definition = characterized\_product\_definition  
characterized\_definition <=  
property\_definition.definition  
property\_definition =>  
product\_definition\_shape <=  
shape\_aspect.of\_shape  
[shape\_aspect <=  
shape\_aspect\_relationship.relate\_shape\_aspect]  
[shape\_aspect <=  
shape\_aspect\_relationship.related\_shape\_aspect]  
shape\_aspect\_relationship =>  
dimensional\_location  
dimensional\_characteristic = dimensional\_location  
dimensional\_characteristic <=  
dimensional\_characteristic\_representation.dimension  
dimensional\_characteristic\_representation  
dimensional\_characteristic\_representation.representation ->  
shape\_dimension\_representation <=  
shape\_representation <=  
{representation  
representation.name = 'stopper dimensional shape'}  
representation  
representation.items[i] ->  
representation\_item =>  
{representation\_item.name = 'length'}  
measure\_representation\_item <=  
{measure\_with\_unit =>  
length\_measure\_with\_unit}  
measure\_with\_unit  
[measure\_with\_unit.value\_component]  
[measure\_with\_unit.unit\_component]

### 5.1.9.65 Straight\_pipe

#1: The attributes are for an individual piping component.

#2: The attributes are for the definition of a family of piping components.

AIM element: #1: (piping\_component\_definition)  
#2: (piping\_component\_class)

Source: 227

Rules: dependent\_instantiable\_product\_context  
product\_context\_discipline\_type\_constraint  
value\_for\_application\_context

Reference path: #1: (piping\_component\_definition <=  
product\_definition  
{piping\_component\_definition  
classification\_item = piping\_component\_definition  
classification\_item <=  
applied\_classification\_assignment.items[i]  
applied\_classification\_assignment <=  
classification\_assignment  
classification\_assignment.assigned\_classification ->  
[group =>  
pipe\_class]  
[group  
group.name = 'straight pipe']}  
{product\_definition  
product\_definition.formation ->  
product\_definition\_formation  
product\_definition\_formation.of\_product ->  
[product  
classification\_item = product  
classification\_item <=  
applied\_classification\_assignment.items[i]  
applied\_classification\_assignment <=  
classification\_assignment  
classification\_assignment.assigned\_classification ->  
(group)  
(group <=  
group\_relationship.related\_group  
group\_relationship  
group\_relationship.relate\_group ->  
group)  
group.name = 'pipe']  
[product  
product.frame\_of\_reference[i] ->  
product\_context<=  
application\_context\_element  
application\_context\_element.name = 'plant item']})  
#2: (piping\_component\_class <=  
[characterized\_object]  
[group])

### 5.1.9.65.1 end\_to\_end\_length

#1: The attributes are for an individual piping component.

#1a: The length is given as a numeric value.

#1b: The length is as required.

#2: The attributes are for the definition of a family of piping components.

AIM element: #1a: ([measure\_with\_unit.value\_component]  
[measure\_with\_unit.unit\_component])

#1b: (descriptive\_representation\_item.description)

#2: ([measure\_with\_unit.value\_component]  
[measure\_with\_unit.unit\_component])

Source: 41, 45

Rules: subtype\_exclusive\_characterized\_object  
subtype\_mandatory\_shape\_representation

Reference path: #1: (piping\_component\_definition <=  
product\_definition  
characterized\_product\_definition = product\_definition  
characterized\_product\_definition  
characterized\_definition = characterized\_product\_definition  
characterized\_definition <=  
property\_definition.definition  
property\_definition =>  
product\_definition\_shape <=  
shape\_aspect.of\_shape  
[[[shape\_aspect =>  
plant\_item\_connector]  
[shape\_aspect  
shape\_aspect.description = 'end 1']}]  
shape\_aspect <=  
shape\_aspect\_relationship.relate\_shape\_aspect]  
[[[shape\_aspect =>  
plant\_item\_connector]  
[shape\_aspect  
shape\_aspect.description = 'end 2']}]  
shape\_aspect <=  
shape\_aspect\_relationship.related\_shape\_aspect]  
#1a: (shape\_aspect\_relationship =>  
dimensional\_location  
dimensional\_characteristic = dimensional\_location  
dimensional\_characteristic <=  
dimensional\_characteristic\_representation.dimension  
dimensional\_characteristic\_representation  
dimensional\_characteristic\_representation.representation ->  
shape\_dimension\_representation <=  
shape\_representation <=  
{representation  
representation.name = 'pipe dimensional shape'}  
representation  
representation.items[i] ->  
{representation\_item  
representation\_item.name = 'end to end length'}  
representation\_item =>  
measure\_representation\_item <=  
{measure\_with\_unit =>  
length\_measure\_with\_unit}  
measure\_with\_unit

```

[measure_with_unit.value_component]
[measure_with_unit.unit_component])
#1b: (shape_aspect_relationship
shape_definition = shape_aspect_relationship
shape_definition
characterized_definition = shape_definition
characterized_definition <-
property_definition.definition
property_definition
represented_definition = property_definition
represented_definition <-
property_definition_representation.definition
property_definition_representation
property_definition_representation.used_representation ->
representation
representation.items[i] ->
{representation_item
representation_item.name = 'end to end length'}
representation_item =>
descriptive_representation_item
descriptive_representation_item.description
{descriptive_representation_item.description = 'as required'}})
#2: (piping_component_class <=
characterized_object
characterized_definition = characterized_object
characterized_definition <-
property_definition.definition
property_definition
represented_definition = property_definition
represented_definition <-
property_definition_representation.definition
property_definition_representation
property_definition_representation.used_representation ->
{representation
representation.name = 'pipe class dimensions'}
representation
(representation.items[i] ->
{representation_item
(representation_item.name = 'maximum end to end length')
(representation_item.name = 'minimum end to end length'}})
([representation.items[i] ->
{representation_item
representation_item.name = 'maximum end to end length'}]
[representation.items[i] ->
{representation_item
representation_item.name = 'minimum end to end length'}}])
representation_item =>
measure_representation_item <=
{measure_with_unit =>
length_measure_with_unit}
measure_with_unit
[measure_with_unit.value_component]
[measure_with_unit.unit_component])

```

**5.1.9.65.2 end\_to\_end\_cut\_length**

#1: The end\_to\_end\_cut\_length is a single value.

#2: The end\_to\_end\_cut\_length is a range of values.

AIM element: [measure\_with\_unit.value\_component]  
[measure\_with\_unit.unit\_component]

Source: 41

Reference path: #1:(piping\_component\_definition <=  
product\_definition  
characterized\_product\_definition = product\_definition  
characterized\_product\_definition  
characterized\_definition = characterized\_product\_definition  
characterized\_definition <=  
property\_definition.definition  
{property\_definition =>  
product\_definition\_shape}  
property\_definition  
represented\_definition = property\_definition  
represented\_definition <=  
property\_definition\_representation.definition  
{property\_definition\_representation =>  
shape\_definition\_representation}  
property\_definition\_representation  
property\_definition\_representation.used\_representation ->  
{representation  
representation.name = 'pipe fabrication dimensional shape'}  
representation  
representation.items[i] ->  
{representation\_item  
representation\_item.name = 'end to end cut length'}  
representation\_item =>  
measure\_representation\_item <=  
{measure\_with\_unit =>  
length\_measure\_with\_unit}  
measure\_with\_unit  
[measure\_with\_unit.value\_component]  
[measure\_with\_unit.unit\_component])  
#2: (piping\_component\_definition <=  
product\_definition  
characterized\_product\_definition = product\_definition  
characterized\_product\_definition  
characterized\_definition = characterized\_product\_definition  
characterized\_definition <=  
property\_definition.definition  
property\_definition  
represented\_definition = property\_definition  
represented\_definition <=  
property\_definition\_representation.definition  
property\_definition\_representation  
property\_definition\_representation.used\_representation ->

```

{representation
representation.name = 'pipe fabrication dimensions'}
representation
(representation.items[i] ->
{representation_item
(representation_item.name = 'maximum end to end length')
(representation_item.name = 'minimum end to end length'}})
([representation.items[i] ->
{representation_item
representation_item.name = 'maximum end to end length'}}]
[representation.items[i] ->
{representation_item
representation_item.name = 'minimum end to end length'}}])
representation_item =>
measure_representation_item <=
{measure_with_unit =>
length_measure_with_unit}
measure_with_unit
[measure_with_unit.value_component]
[measure_with_unit.unit_component])

```

### 5.1.9.66 Swept\_bend\_pipe

AIM element:	piping_component_definition
Source:	227
Rules:	dependent_instantiable_product_context product_context_discipline_type_constraint value_for_application_context
Reference path:	<pre> piping_component_definition &lt;= product_definition {piping_component_definition classification_item = piping_component_definition classification_item &lt;- applied_classification_assignment.items[i] applied_classification_assignment &lt;= classification_assignment classification_assignment.assigned_classification -&gt; [group =&gt; pipe_class] [group group.name = 'swept bend pipe']} {product_definition product_definition.formation -&gt; product_definition_formation product_definition_formation.of_product -&gt; [product classification_item = product classification_item &lt;- applied_classification_assignment.items[i] applied_classification_assignment &lt;= classification_assignment </pre>

```

classification_assignment.assigned_classification ->
(group)
(group <-
group_relationship.related_group
group_relationship
group_relationship.relate_group ->
group)
group.name = 'pipe']
[product
product.frame_of_reference[i] ->
product_context<=
application_context_element
application_context_element.name = 'plant item']]

```

### 5.1.9.66.1 wall\_thinning\_allowance

AIM element: [measure\_with\_unit.value\_component]  
[measure\_with\_unit.unit\_component]

Source: 41

Rules: subtype\_mandatory\_shape\_representation

Reference path: piping\_component\_definition <=  
product\_definition  
characterized\_product\_definition = product\_definition  
characterized\_product\_definition  
characterized\_definition = characterized\_product\_definition  
characterized\_definition <=  
property\_definition.definition  
property\_definition =>  
product\_definition\_shape <=  
shape\_aspect.of\_shape  
[shape\_aspect <=  
shape\_aspect\_relationship.relate\_shape\_aspect]  
[shape\_aspect <=  
shape\_aspect\_relationship.related\_shape\_aspect]  
shape\_aspect\_relationship =>  
dimensional\_location  
dimensional\_characteristic = dimensional\_location  
dimensional\_characteristic <=  
dimensional\_characteristic\_representation.dimension  
dimensional\_characteristic\_representation  
dimensional\_characteristic\_representation.representation ->  
shape\_dimension\_representation <=  
shape\_representation <=  
{representation  
representation.name = 'swept bend pipe dimensional shape'}  
representation  
representation.items[i] ->  
{representation\_item  
representation\_item.name = 'wall thinning allowance'}  
representation\_item =>  
measure\_representation\_item <=

```

{measure_with_unit =>
length_measure_with_unit}
measure_with_unit
[measure_with_unit.value_component]
[measure_with_unit.unit_component]

```

### 5.1.9.66.2 centreline\_radius

AIM element: [measure\_with\_unit.value\_component]  
[measure\_with\_unit.unit\_component]

Source: 41

Reference path: piping\_component\_definition <=  
product\_definition  
characterized\_product\_definition = product\_definition  
characterized\_product\_definition  
characterized\_definition = characterized\_product\_definition  
characterized\_definition <=  
property\_definition.definition  
property\_definition =>  
product\_definition\_shape <=  
shape\_aspect.of\_shape  
{shape\_aspect  
shape\_aspect.description = 'pipe bend'}  
shape\_aspect <=  
[shape\_aspect\_relationship.relying\_shape\_aspect  
{shape\_aspect\_relationship  
shape\_aspect\_relationship.name = 'pipe bend sweep angle centre point'}  
shape\_aspect\_relationship  
shape\_aspect\_relationship.related\_shape\_aspect ->  
{shape\_aspect  
shape\_aspect.description = 'sweep angle centre point'}  
shape\_aspect <=  
shape\_aspect\_relationship.relying\_shape\_aspect]  
[shape\_aspect\_relationship.relying\_shape\_aspect  
shape\_aspect\_relationship  
{shape\_aspect\_relationship  
shape\_aspect\_relationship.name = 'pipe bend sweep angle centreline'}  
shape\_aspect\_relationship.related\_shape\_aspect ->  
{shape\_aspect  
shape\_aspect.description = 'pipe centreline'}  
shape\_aspect <=  
shape\_aspect\_relationship.related\_shape\_aspect]  
shape\_aspect\_relationship =>  
dimensional\_location  
dimensional\_characteristic = dimensional\_location  
dimensional\_characteristic <=  
dimensional\_characteristic\_representation.dimension  
dimensional\_characteristic\_representation  
dimensional\_characteristic\_representation.representation ->  
shape\_dimension\_representation <=  
shape\_representation <=  
{representation

```

representation.name = 'pipe bend dimensional shape'}
representation
representation.items[i] ->
{representation_item
representation_item.name = 'centreline radius'}
representation_item =>
measure_representation_item <=
{measure_with_unit =>
length_measure_with_unit}
measure_with_unit
[measure_with_unit.value_component]
[measure_with_unit.unit_component]

```

### 5.1.9.66.3 sweep\_angle

AIM element: [measure\_with\_unit.value\_component]  
[measure\_with\_unit.unit\_component]

Source: 41

Reference path: piping\_component\_definition <=  
product\_definition  
characterized\_product\_definition = product\_definition  
characterized\_product\_definition  
characterized\_definition = characterized\_product\_definition  
characterized\_definition <=  
property\_definition.definition  
property\_definition =>  
product\_definition\_shape <=  
shape\_aspect.of\_shape  
{shape\_aspect  
shape\_aspect.description = 'pipe bend'}  
shape\_aspect <=  
[shape\_aspect\_relationship.relate\_shape\_aspect  
{shape\_aspect\_relationship  
shape\_aspect\_relationship.name = 'pipe bend start'}  
shape\_aspect\_relationship  
shape\_aspect\_relationship.related\_shape\_aspect ->  
{shape\_aspect  
shape\_aspect.description = 'pipe bend start'}  
shape\_aspect <=  
shape\_aspect\_relationship.relate\_shape\_aspect]  
[shape\_aspect\_relationship.relate\_shape\_aspect  
shape\_aspect\_relationship  
{shape\_aspect\_relationship  
shape\_aspect\_relationship.name = 'pipe bend end'}  
shape\_aspect\_relationship.related\_shape\_aspect ->  
{shape\_aspect  
shape\_aspect.description = 'pipe bend end'}  
shape\_aspect <=  
shape\_aspect\_relationship.related\_shape\_aspect]  
shape\_aspect\_relationship =>  
dimensional\_location  
dimensional\_characteristic = dimensional\_location

```

dimensional_characteristic <-
dimensional_characteristic_representation.dimension
dimensional_characteristic_representation
dimensional_characteristic_representation.representation ->
shape_dimension_representation <=
shape_representation <=
{representation
representation.name = 'pipe bend dimensional shape'}
representation
representation.items[i] ->
{representation_item
representation_item.name = 'centreline radius'}
representation_item =>
measure_representation_item <=
{measure_with_unit =>
length_measure_with_unit}
measure_with_unit
[measure_with_unit.value_component]
[measure_with_unit.unit_component]

```

### 5.1.9.67 Tee

#1: The attributes are for an individual piping component.

#2: The attributes are for the definition of a family of piping components.

AIM element: #1: (piping\_component\_definition)  
#2: (piping\_component\_class)

Source: 227

Rules: dependent\_instantiable\_product\_context  
product\_context\_discipline\_type\_constraint  
value\_for\_application\_context

Reference path: #1: (piping\_component\_definition <=
product\_definition
{product\_definition
product\_definition.formation ->
product\_definition\_formation
product\_definition\_formation.of\_product ->
[product
classification\_item = product
classification\_item <-
applied\_classification\_assignment.items[i]
applied\_classification\_assignment <=
classification\_assignment
classification\_assignment.assigned\_classification ->
(group)
(group <-
group\_relationship.related\_group
group\_relationship
group\_relationship.relating\_group ->
group)

```

group.name = 'tee']
[product
product.frame_of_reference[i] ->
product_context<=
application_context_element
application_context_element.name = 'plant item']]
#2: (piping_component_class <=
[characterized_object]
[group])

```

### 5.1.9.67.1 centre\_to\_end\_1\_length

#1: The attributes are for an individual piping component.

#2: The attributes are for the definition of a family of piping components.

AIM element: [measure\_with\_unit.value\_component]  
[measure\_with\_unit.unit\_component]

Source: 41

Rules: subtype\_exclusive\_characterized\_object  
subtype\_mandatory\_shape\_representation

Reference path: #1: (piping\_component\_definition <=

```

product_definition
characterized_product_definition = product_definition
characterized_product_definition
characterized_definition = characterized_product_definition
characterized_definition <-
property_definition.definition
property_definition =>
product_definition_shape <-
[shape_aspect.of_shape
{shape_aspect
shape_aspect.description = 'centre'}
shape_aspect <-
shape_aspect_relationship.relate_shape_aspect]
[shape_aspect.of_shape
{[shape_aspect =>
plant_item_connector]
[shape_aspect
shape_aspect.description = 'end 1']}
shape_aspect <-
shape_aspect_relationship.related_shape_aspect]
shape_aspect_relationship =>
dimensional_location
dimensional_characteristic = dimensional_location
dimensional_characteristic <-
dimensional_characteristic_representation.dimension
dimensional_characteristic_representation
dimensional_characteristic_representation.representation ->
shape_dimension_representation <=
shape_representation <=

```

```

{representation
representation.name = 'tee fitting dimensional shape'}
representation
representation.items[i] ->
{representation_item
representation_item.name = 'centre to end 1 length'}}
#2: (piping_component_class <=
characterized_object
characterized_definition = characterized_object
characterized_definition <-
property_definition.definition
property_definition
represented_definition = property_definition
represented_definition <-
property_definition_representation.definition
property_definition_representation
property_definition_representation.used_representation ->
{representation
representation.name = 'tee fitting class dimensions'}
representation
(representation.items[i] ->
{representation_item
(representation_item.name = 'maximum centre to end 1 length')
(representation_item.name = 'minimum centre to end 1 length'}})
([representation.items[i] ->
{representation_item
representation_item.name = 'maximum centre to end 1 length'}}]
[representation.items[i] ->
{representation_item
representation_item.name = 'minimum centre to end 1 length'}}]))
representation_item =>
measure_representation_item <=
{measure_with_unit =>
length_measure_with_unit}
measure_with_unit
[measure_with_unit.value_component]
[measure_with_unit.unit_component]

```

### 5.1.9.67.2 centre\_to\_end\_2\_length

#1: The attributes are for an individual piping component.

#2: The attributes are for the definition of a family of piping components.

AIM element: [measure\_with\_unit.value\_component]  
[measure\_with\_unit.unit\_component]

Source: 41

Rules: subtype\_exclusive\_characterized\_object  
subtype\_mandatory\_shape\_representation

Reference path: #1: (piping\_component\_definition <= product\_definition

```

characterized_product_definition = product_definition
characterized_product_definition
characterized_definition = characterized_product_definition
characterized_definition <-
property_definition.definition
property_definition =>
product_definition_shape <-
[shape_aspect.of_shape
{shape_aspect
shape_aspect.description = 'centre'}
shape_aspect <-
shape_aspect_relationship.relateing_shape_aspect]
[shape_aspect.of_shape
{[shape_aspect =>
plant_item_connector]
[shape_aspect
shape_aspect.description = 'end 2']}]
shape_aspect <-
shape_aspect_relationship.related_shape_aspect]
shape_aspect_relationship =>
dimensional_location
dimensional_characteristic = dimensional_location
dimensional_characteristic <-
dimensional_characteristic_representation.dimension
dimensional_characteristic_representation
dimensional_characteristic_representation.representation ->
shape_dimension_representation <=
shape_representation <=
{representation
representation.name = 'tee fitting dimensional shape'}
representation
representation.items[i] ->
{representation_item
representation_item.name = 'centre to end 2 length'})
#2: (piping_component_class <=
characterized_object
characterized_definition = characterized_object
characterized_definition <-
property_definition.definition
property_definition
represented_definition = property_definition
represented_definition <-
property_definition_representation.definition
property_definition_representation
property_definition_representation.used_representation ->
{representation
representation.name = 'tee fitting class dimensions'}
representation
(representation.items[i] ->
{representation_item
(representation_item.name = 'maximum centre to end 2 length')
(representation_item.name = 'minimum centre to end 2 length'}})
([representation.items[i] ->
{representation_item

```

```

representation_item.name = 'maximum centre to end 2 length'}}
[representation.items[i] ->
{representation_item
representation_item.name = 'minimum centre to end 2 length'}}))
representation_item =>
measure_representation_item <=
{measure_with_unit =>
length_measure_with_unit}
measure_with_unit
[measure_with_unit.value_component]
[measure_with_unit.unit_component]

```

### 5.1.9.67.3 centre\_to\_end\_3\_length

#1: The attributes are for an individual piping component.

#2: The attributes are for the definition of a family of piping components.

AIM element: [measure\_with\_unit.value\_component]  
[measure\_with\_unit.unit\_component]

Source: 41

Rules: subtype\_exclusive\_characterized\_object  
subtype\_mandatory\_shape\_representation

Reference path: #1: (piping\_component\_definition <=  
product\_definition  
characterized\_product\_definition = product\_definition  
characterized\_product\_definition  
characterized\_definition = characterized\_product\_definition  
characterized\_definition <=  
property\_definition.definition  
property\_definition =>  
product\_definition\_shape <=  
[shape\_aspect.of\_shape  
{shape\_aspect  
shape\_aspect.description = 'centre'}  
shape\_aspect <=  
shape\_aspect\_relationship.relying\_shape\_aspect]  
[shape\_aspect.of\_shape  
{[shape\_aspect =>  
plant\_item\_connector]  
[shape\_aspect  
shape\_aspect.description = 'end 3']}]  
shape\_aspect <=  
shape\_aspect\_relationship.related\_shape\_aspect]  
shape\_aspect\_relationship =>  
dimensional\_location  
dimensional\_characteristic = dimensional\_location  
dimensional\_characteristic <=  
dimensional\_characteristic\_representation.dimension  
dimensional\_characteristic\_representation  
dimensional\_characteristic\_representation.representation ->

```

shape_dimension_representation <=
shape_representation <=
{representation
representation.name = 'tee fitting dimensional shape'}
representation
representation.items[i] ->
{representation_item
representation_item.name = 'centre to end 3 length'}}
#2: (piping_component_class <=
characterized_object
characterized_definition = characterized_object
characterized_definition <-
property_definition.definition
property_definition
represented_definition = property_definition
represented_definition <-
property_definition_representation.definition
property_definition_representation
property_definition_representation.used_representation ->
{representation
representation.name = 'tee fitting class dimensions'}
representation
(representation.items[i] ->
{representation_item
(representation_item.name = 'maximum centre to end 3 length')
(representation_item.name = 'minimum centre to end 3 length'}})
([representation.items[i] ->
{representation_item
representation_item.name = 'maximum centre to end 3 length'}}
[representation.items[i] ->
{representation_item
representation_item.name = 'minimum centre to end 3 length'}})])
representation_item =>
measure_representation_item <=
{measure_with_unit =>
length_measure_with_unit}
measure_with_unit
[measure_with_unit.value_component]
[measure_with_unit.unit_component]

```

#### 5.1.9.67.4 end\_1\_connector

AIM element: plant\_item\_connector

Source: 227

Reference path: piping\_component\_definition <=

```

product_definition
characterized_product_definition = product_definition
characterized_product_definition
characterized_definition = characterized_product_definition
characterized_definition <-
property_definition.definition
property_definition =>

```

```

product_definition_shape <-
shape_aspect.of_shape
{shape_aspect
shape_aspect.description = 'end 1'}
shape_aspect =>
plant_item_connector

```

#### **5.1.9.67.5 end\_2\_connector**

AIM element: plant\_item\_connector

Source: 227

Reference path:

```

piping_component_definition <=
product_definition
characterized_product_definition = product_definition
characterized_product_definition
characterized_definition = characterized_product_definition
characterized_definition <-
property_definition.definition
property_definition =>
product_definition_shape <-
shape_aspect.of_shape
{shape_aspect
shape_aspect.description = 'end 2'}
shape_aspect =>
plant_item_connector

```

#### **5.1.9.67.6 end\_3\_connector**

AIM element: plant\_item\_connector

Source: 227

Reference path:

```

piping_component_definition <=
product_definition
characterized_product_definition = product_definition
characterized_product_definition
characterized_definition = characterized_product_definition
characterized_definition <-
property_definition.definition
property_definition =>
product_definition_shape <-
shape_aspect.of_shape
{shape_aspect
shape_aspect.description = 'end 3'}
shape_aspect =>
plant_item_connector

```

#### **5.1.9.68 Threaded flange**

AIM element: piping\_component\_definition

Source: 227

Rules: dependent\_instantiable\_product\_context  
product\_context\_discipline\_type\_constraint  
value\_for\_application\_context

Reference path: piping\_component\_definition <=  
product\_definition  
{piping\_component\_definition  
classification\_item = piping\_component\_definition  
classification\_item <=  
applied\_classification\_assignment.items[i]  
applied\_classification\_assignment <=  
classification\_assignment  
classification\_assignment.assigned\_classification ->  
[group =>  
flange\_fitting\_neck\_type\_class]  
[group  
group.name = 'threaded flange']}  
{product\_definition  
product\_definition.formation ->  
product\_definition\_formation  
product\_definition\_formation.of\_product ->  
[product  
classification\_item = product  
classification\_item <=  
applied\_classification\_assignment.items[i]  
applied\_classification\_assignment <=  
classification\_assignment  
classification\_assignment.assigned\_classification ->  
(group)  
(group <=  
group\_relationship.related\_group  
group\_relationship  
group\_relationship.relying\_group ->  
group)  
group.name = 'flange']  
[product  
product.frame\_of\_reference[i] ->  
product\_context<=  
application\_context\_element  
application\_context\_element.name = 'plant item']]}

### 5.1.9.69 Union

#1: The attributes are for an individual piping component.

#2: The attributes are for the definition of a family of piping components.

AIM element: #1: (piping\_component\_definition)  
#2: (piping\_component\_class)

Source: 227

Rules: dependent\_instantiable\_product\_context  
product\_context\_discipline\_type\_constraint  
value\_for\_application\_context

Reference path: #1: (piping\_component\_definition <=  
product\_definition  
{product\_definition  
product\_definition.formation ->  
product\_definition\_formation  
product\_definition\_formation.of\_product ->  
[product  
classification\_item = product  
classification\_item <-  
applied\_classification\_assignment.items[i]  
applied\_classification\_assignment <=  
classification\_assignment  
classification\_assignment.assigned\_classification ->  
(group)  
(group <-  
group\_relationship.related\_group  
group\_relationship  
group\_relationship.relying\_group ->  
group)  
group.name = 'union']  
[product  
product.frame\_of\_reference[i] ->  
product\_context<=  
application\_context\_element  
application\_context\_element.name = 'plant item']})  
#2: (piping\_component\_class <=  
[characterized\_object]  
[group])

### 5.1.9.69.1 end\_1\_connector

AIM element: plant\_item\_connector

Source: 227

Reference path: piping\_component\_definition <=  
product\_definition  
characterized\_product\_definition = product\_definition  
characterized\_product\_definition  
characterized\_definition = characterized\_product\_definition  
characterized\_definition <-  
property\_definition.definition  
property\_definition =>  
product\_definition\_shape <-  
shape\_aspect.of\_shape  
{shape\_aspect  
shape\_aspect.description = 'end 1'}  
shape\_aspect =>  
plant\_item\_connector

**5.1.9.69.2 end\_2\_connector**

AIM element: plant\_item\_connector

Source: 227

Reference path: piping\_component\_definition <=  
product\_definition  
characterized\_product\_definition = product\_definition  
characterized\_product\_definition  
characterized\_definition = characterized\_product\_definition  
characterized\_definition <=  
property\_definition.definition  
property\_definition =>  
product\_definition\_shape <=  
shape\_aspect.of\_shape  
{shape\_aspect  
shape\_aspect.description = 'end 2'}  
shape\_aspect =>  
plant\_item\_connector

**5.1.9.69.3 end\_to\_end\_length**

#1: The attributes are for an individual piping component.

#2: The attributes are for the definition of a family of piping components.

AIM element: [measure\_with\_unit.value\_component]  
[measure\_with\_unit.unit\_component]

Source: 41

Rules: subtype\_exclusive\_characterized\_object  
subtype\_mandatory\_shape\_representation

Reference path: #1: (piping\_component\_definition <=  
product\_definition  
characterized\_product\_definition = product\_definition  
characterized\_product\_definition  
characterized\_definition = characterized\_product\_definition  
characterized\_definition <=  
property\_definition.definition  
property\_definition =>  
product\_definition\_shape <=  
shape\_aspect.of\_shape  
[{{shape\_aspect =>  
plant\_item\_connector]  
[shape\_aspect  
shape\_aspect.description = 'end 1']}]  
shape\_aspect <=  
shape\_aspect\_relationship.relying\_shape\_aspect]  
[{{shape\_aspect =>  
plant\_item\_connector]  
[shape\_aspect

```

shape_aspect.description = 'end 2'])
shape_aspect <-
shape_aspect_relationship.related_shape_aspect]
shape_aspect_relationship =>
dimensional_location
dimensional_characteristic = dimensional_location
dimensional_characteristic <-
dimensional_characteristic_representation.dimension
dimensional_characteristic_representation
dimensional_characteristic_representation.representation ->
shape_dimension_representation <=
shape_representation <=
{representation
representation.name = 'union fitting dimensional shape'}
representation
representation.items[i] ->
{representation_item
representation_item.name = 'end to end length'})
#2: (piping_component_class <=
characterized_object
characterized_definition = characterized_object
characterized_definition <-
property_definition.definition
property_definition
represented_definition = property_definition
represented_definition <-
property_definition_representation.definition
property_definition_representation
property_definition_representation.used_representation ->
{representation
representation.name = 'union fitting class dimensions'}
representation
(representation.items[i] ->
{representation_item
(representation_item.name = 'maximum end to end length')
(representation_item.name = 'minimum end to end length'}})
([representation.items[i] ->
{representation_item
representation_item.name = 'maximum end to end length'}]
[representation.items[i] ->
{representation_item
representation_item.name = 'minimum end to end length'}}]))
representation_item =>
measure_representation_item <=
{measure_with_unit =>
length_measure_with_unit}
measure_with_unit
[measure_with_unit.value_component]
[measure_with_unit.unit_component]

```

#### 5.1.9.69.4 major\_outside\_diameter

#1: The attributes are for an individual piping component.

#2: The attributes are for the definition of a family of piping components.

AIM element: [measure\_with\_unit.value\_component]  
[measure\_with\_unit.unit\_component]

Source: 41

Rules: subtype\_exclusive\_characterized\_object  
subtype\_mandatory\_shape\_representation

Reference path: #1: (piping\_component\_definition <=  
product\_definition  
characterized\_product\_definition = product\_definition  
characterized\_product\_definition  
characterized\_definition = characterized\_product\_definition  
characterized\_definition <=  
property\_definition.definition  
property\_definition =>  
product\_definition\_shape <=  
shape\_aspect.of\_shape  
shape\_aspect <=  
dimensional\_size.applies\_to  
dimensional\_size  
dimensional\_characteristic = dimensional\_size  
dimensional\_characteristic <=  
dimensional\_characteristic\_representation.dimension  
dimensional\_characteristic\_representation  
dimensional\_characteristic\_representation.representation ->  
shape\_dimension\_representation <=  
shape\_representation <=  
{representation  
representation.name = 'union fitting dimensional shape'}  
representation  
representation.items[i] ->  
{representation\_item  
representation\_item.name = 'major outside diameter'}})  
#2: (piping\_component\_class <=  
characterized\_object  
characterized\_definition = characterized\_object  
characterized\_definition <=  
property\_definition.definition  
property\_definition  
represented\_definition = property\_definition  
represented\_definition <=  
property\_definition\_representation.definition  
property\_definition\_representation  
property\_definition\_representation.used\_representation ->  
{representation  
representation.name = 'union fitting class dimensions'}  
representation  
(representation.items[i] ->  
{representation\_item

```

(representation_item.name = 'maximum major outside diameter')
(representation_item.name = 'minimum major outside diameter'))
([representation.items[i] ->
 {representation_item
 representation_item.name = 'maximum major outside diameter'}}
 [representation.items[i] ->
 {representation_item
 representation_item.name = 'minimum major outside diameter'}}))
representation_item =>
measure_representation_item <=
 {measure_with_unit =>
 length_measure_with_unit}
measure_with_unit
 [measure_with_unit.value_component]
 [measure_with_unit.unit_component]

```

### 5.1.9.69.5 minor\_outside\_diameter

#1: The attributes are for an individual piping component.

#2: The attributes are for the definition of a family of piping components.

AIM element: [measure\_with\_unit.value\_component]  
[measure\_with\_unit.unit\_component]

Source: 41

Rules: subtype\_exclusive\_characterized\_object  
subtype\_mandatory\_shape\_representation

Reference path: #1: (piping\_component\_definition <=  
product\_definition  
characterized\_product\_definition = product\_definition  
characterized\_product\_definition  
characterized\_definition = characterized\_product\_definition  
characterized\_definition <=  
property\_definition.definition  
property\_definition =>  
product\_definition\_shape <=  
shape\_aspect.of\_shape  
shape\_aspect <=  
dimensional\_size.applies\_to  
dimensional\_size  
dimensional\_characteristic = dimensional\_size  
dimensional\_characteristic <=  
dimensional\_characteristic\_representation.dimension  
dimensional\_characteristic\_representation  
dimensional\_characteristic\_representation.representation ->  
shape\_dimension\_representation <=  
shape\_representation <=  
{representation  
representation.name = 'union fitting dimensional shape'}  
representation  
representation.items[i] ->

```

{representation_item
representation_item.name = 'minor outside diameter'})
#2: (piping_component_class <=
characterized_object
characterized_definition = characterized_object
characterized_definition <-
property_definition.definition
property_definition
represented_definition = property_definition
represented_definition <-
property_definition_representation.definition
property_definition_representation
property_definition_representation.used_representation ->
{representation
representation.name = 'union fitting class dimensions'}
representation
(representation.items[i] ->
{representation_item
(representation_item.name = 'maximum minor outside diameter')
(representation_item.name = 'minimum minor outside diameter'}})
([representation.items[i] ->
{representation_item
representation_item.name = 'maximum minor outside diameter'}]
[representation.items[i] ->
{representation_item
representation_item.name = 'minimum minor outside diameter'}}]))
representation_item =>
measure_representation_item <=
{measure_with_unit =>
length_measure_with_unit}
measure_with_unit
[measure_with_unit.value_component]
[measure_with_unit.unit_component]

```

### 5.1.9.70 Valve

AIM element:       piping\_component\_definition

Source:            227

Rules:             dependent\_instantiable\_product\_context  
                     product\_context\_discipline\_type\_constraint  
                     value\_for\_application\_context

Reference path:    piping\_component\_definition <=  
                     product\_definition  
                     {product\_definition  
                     product\_definition.formation ->  
                     product\_definition\_formation  
                     product\_definition\_formation.of\_product ->  
                     [product  
                     classification\_item = product  
                     classification\_item <-  
                     applied\_classification\_assignment.items[i]

```

applied_classification_assignment <=
classification_assignment
classification_assignment.assigned_classification ->
(group)
(group <-
group_relationship.related_group
group_relationship
group_relationship.relying_group ->
group)
group.name = 'valve']
[product
product.frame_of_reference[i] ->
product_context<=
application_context_element
application_context_element.name = 'plant item']]

```

### 5.1.9.70.1 actuator\_type

AIM element: descriptive\_representation\_item.description

Source: 45

Reference path: piping\_component\_definition <=

```

product_definition
characterized_product_definition = product_definition
characterized_product_definition
characterized_definition = characterized_product_definition
characterized_definition <-
property_definition.definition
property_definition
represented_definition = property_definition
represented_definition <-
property_definition_representation.definition
property_definition_representation
property_definition_representation.used_representation ->
representation
representation.items[i] ->
{representation_item
representation_item.name = 'actuator type'}
representation_item =>
descriptive_representation_item
descriptive_representation_item.description

```

### 5.1.9.70.2 operation\_mode

AIM element: descriptive\_representation\_item.description

Source: 45

Reference path: piping\_component\_definition <=

```

product_definition
characterized_product_definition = product_definition
characterized_product_definition

```

```

characterized_definition = characterized_product_definition
characterized_definition <-
property_definition.definition
property_definition
represented_definition = property_definition
represented_definition <-
property_definition_representation.definition
property_definition_representation
property_definition_representation.used_representation ->
representation
representation.items[i] ->
{representation_item
representation_item.name = 'operation mode'}
representation_item =>
descriptive_representation_item
descriptive_representation_item.description

```

### 5.1.9.70.3 type

AIM element: group.name

Source: 41

Reference path:

```

piping_component_definition
classification_item = piping_component_definition
classification_item <-
applied_classification_assignment.items[i]
applied_classification_assignment <=
{classification_assignment
classification_assignment.role ->
classification_role
classification_role.name = 'valve type classification'}
classification_assignment
classification_assignment.assigned_classification ->
{group =>
valve_class}
group
group.name

```

### 5.1.9.70.4 end\_to\_end\_length

AIM element: [measure\_with\_unit.value\_component]  
[measure\_with\_unit.unit\_component]

Source: 41

Reference path:

```

piping_component_definition <=
product_definition
characterized_product_definition = product_definition
characterized_product_definition
characterized_definition = characterized_product_definition
characterized_definition <-
property_definition.definition

```

```

property_definition =>
product_definition_shape <-
shape_aspect.of_shape
[[[shape_aspect =>
plant_item_connector]
[shape_aspect
shape_aspect.description = 'end 1']]
shape_aspect <-
shape_aspect_relationship.relate_shape_aspect]
[[[shape_aspect =>
plant_item_connector]
[shape_aspect
shape_aspect.description = 'end 2']]
shape_aspect <-
shape_aspect_relationship.related_shape_aspect]
shape_aspect_relationship =>
dimensional_location
dimensional_characteristic = dimensional_location
dimensional_characteristic <-
dimensional_characteristic_representation.dimension
dimensional_characteristic_representation
dimensional_characteristic_representation.representation ->
shape_dimension_representation <=
shape_representation <=
{representation
representation.name = 'valve dimensional shape'}
representation
representation.items[i] ->
{representation_item
representation_item.name = 'end to end length'}
representation_item =>
measure_representation_item <=
{measure_with_unit =>
length_measure_with_unit}
measure_with_unit
[measure_with_unit.value_component]
[measure_with_unit.unit_component]

```

### 5.1.9.70.5 valve\_stem\_orientation

AIM element: axis2\_placement\_3d.ref\_direction

Source: 42

Reference path: (piping\_component\_definition <=

```

product_definition
characterized_product_definition
characterized_definition = characterized_product_definition
characterized_definition <-
property_definition.definition
{property_definition =>
product_definition_shape}
property_definition
represented_definition = property_definition

```

```

represented_definition <-
property_definition_representation.definition
{property_definition_representation =>
shape_definition_representation}
property_definition_representation
property_definition_representation.used_representation ->
representation
representation.items [i] ->
{representation_item
representation_item.name = 'valve stem orientation'}
representation_item =>
geometric_representation_item =>
placement =>
axis2_placement_3d
axis2_placement_3d.ref_direction

```

### 5.1.9.71 Weld\_neck\_flange

AIM element: piping\_component\_definition

Source: 227

Rules: dependent\_instantiable\_product\_context  
product\_context\_discipline\_type\_constraint  
value\_for\_application\_context

Reference path: piping\_component\_definition <=  
product\_definition  
{piping\_component\_definition  
classification\_item = piping\_component\_definition  
classification\_item <=  
applied\_classification\_assignment.items[i]  
applied\_classification\_assignment <=  
classification\_assignment  
classification\_assignment.assigned\_classification ->  
[group =>  
flange\_fitting\_neck\_type\_class]  
[group  
group.name = 'weld neck flange']}  
{product\_definition  
product\_definition.formation ->  
product\_definition\_formation  
product\_definition\_formation.of\_product ->  
[product  
classification\_item = product  
classification\_item <=  
applied\_classification\_assignment.items[i]  
applied\_classification\_assignment <=  
classification\_assignment  
classification\_assignment.assigned\_classification ->  
(group)  
(group <=  
group\_relationship.related\_group  
group\_relationship

```

group_relationship.relatng_group ->
group)
group.name = 'flange']
[product
product.frame_of_reference[i] ->
product_context<=
application_context_element
application_context_element.name = 'plant item']]

```

### 5.1.9.72 Weld\_neck\_jacket\_flange

AIM element:       piping\_component\_definition

Source:            227

Rules:             dependent\_instantiable\_product\_context  
product\_context\_discipline\_type\_constraint  
value\_for\_application\_context

Reference path:    piping\_component\_definition <=  
product\_definition  
{piping\_component\_definition  
classification\_item = piping\_component\_definition  
classification\_item <=  
applied\_classification\_assignment.items[i]  
applied\_classification\_assignment <=  
classification\_assignment  
classification\_assignment.assigned\_classification ->  
[group =>  
flange\_fitting\_neck\_type\_class]  
[group  
group.name = 'weld neck jacket flange']  
[group <=  
group\_relationship.related\_group  
{group\_relationship  
group\_relationship.name = 'class hierarchy'}  
group\_relationship  
group\_relationship.relatng\_group ->  
group  
group.name = 'weld neck flange']}  
{product\_definition  
product\_definition.formation ->  
product\_definition\_formation  
product\_definition\_formation.of\_product ->  
[product  
classification\_item = product  
classification\_item <=  
applied\_classification\_assignment.items[i]  
applied\_classification\_assignment <=  
{classification\_assignment  
classification\_assignment.role ->  
group\_role  
group\_role.name = 'plant item type'}  
classification\_assignment

```

classification_assignment.assigned_classification ->
(group)
(group <-
group_relationship.related_group
group_relationship
group_relationship.relate_group ->
group)
group.name = 'weld neck jacket flange']
[product
product.frame_of_reference[i] ->
product_context<=
application_context_element
application_context_element.name = 'plant item']]

```

### 5.1.9.72.1 end\_3\_connector

AIM element: plant\_item\_connector

Source: 227

Reference path: piping\_component\_definition <=  
product\_definition  
characterized\_product\_definition = product\_definition  
characterized\_product\_definition  
characterized\_definition = characterized\_product\_definition  
characterized\_definition <=  
property\_definition.definition  
property\_definition =>  
product\_definition\_shape <=  
shape\_aspect.of\_shape  
{shape\_aspect  
shape\_aspect.description = 'end 1'}  
shape\_aspect =>  
plant\_item\_connector

### 5.1.9.73 Y\_type\_lateral

#1: The attributes are for an individual piping component.

#2: The attributes are for the definition of a family of piping components.

AIM element: #1: (piping\_component\_definition)  
#2: (piping\_component\_class)

Source: 227

Rules: dependent\_instantiable\_product\_context  
product\_context\_discipline\_type\_constraint  
value\_for\_application\_context

Reference path: #1: (piping\_component\_definition <=  
product\_definition  
{product\_definition

```

product_definition.formation ->
product_definition_formation
product_definition_formation.of_product ->
[product
classification_item = product
classification_item <-
applied_classification_assignment.items[i]
applied_classification_assignment <=
classification_assignment
classification_assignment.assigned_classification ->
(group)
(group <-
group_relationship.related_group
group_relationship
group_relationship.relatng_group ->
group)
group.name = 'Y type lateral']
[product
product.frame_of_reference[i] ->
product_context<=
application_context_element
application_context_element.name = 'plant item']]
#2: (piping_component_class <=
[characterized_object]
[group])

```

### 5.1.9.73.1 angle

#1: The attributes are for an individual piping component.

#2: The attributes are for the definition of a family of piping components.

AIM element: [measure\_with\_unit.value\_component]  
[measure\_with\_unit.unit\_component]

Source: 41

Rules: subtype\_exclusive\_characterized\_object  
subtype\_mandatory\_shape\_representation

Reference path: #1: (piping\_component\_definition <=
product\_definition
characterized\_product\_definition = product\_definition
characterized\_product\_definition
characterized\_definition = characterized\_product\_definition
characterized\_definition <-
property\_definition.definition
property\_definition =>
product\_definition\_shape <-
shape\_aspect.of\_shape
[shape\_aspect <-
shape\_aspect\_relationship.relatng\_shape\_aspect]
[shape\_aspect <-
shape\_aspect\_relationship.related\_shape\_aspect]

```

shape_aspect_relationship =>
{dimensional_location =>
angular_location}
dimensional_location
dimensional_characteristic = dimensional_location
dimensional_characteristic <-
dimensional_characteristic_representation.dimension
dimensional_characteristic_representation
dimensional_characteristic_representation.representation ->
shape_dimension_representation <=
shape_representation <=
{representation
representation.name = 'y type lateral fitting dimensional shape'}
representation
representation.items[i] ->
{representation_item
representation_item.name = 'angle'})
#2: (piping_component_class <=
characterized_object
characterized_definition = characterized_object
characterized_definition <-
property_definition.definition
property_definition
represented_definition = property_definition
represented_definition <-
property_definition_representation.definition
property_definition_representation
property_definition_representation.used_representation ->
{representation
representation.name = 'y type lateral fitting class dimensions'}
representation
(representation.items[i] ->
{representation_item
(representation_item.name = 'maximum angle')
(representation_item.name = 'minimum angle'))
([representation.items[i] ->
{representation_item
representation_item.name = 'maximum angle'}]
[representation.items[i] ->
{representation_item
representation_item.name = 'minimum angle'}]))
representation_item =>
measure_representation_item <=
{measure_with_unit =>
plane_angle_measure_with_unit}
measure_with_unit
[measure_with_unit.value_component]
[measure_with_unit.unit_component]

```

### 5.1.9.73.2 centre\_to\_end\_1\_length

#1: The attributes are for an individual piping component.

#2: The attributes are for the definition of a family of piping components.

AIM element: [measure\_with\_unit.value\_component]  
[measure\_with\_unit.unit\_component]

Source: 41

Rules: subtype\_exclusive\_characterized\_object  
subtype\_mandatory\_shape\_representation

Reference path: #1: (piping\_component\_definition <=  
product\_definition  
characterized\_product\_definition = product\_definition  
characterized\_product\_definition  
characterized\_definition = characterized\_product\_definition  
characterized\_definition <=  
property\_definition.definition  
property\_definition =>  
product\_definition\_shape <=  
[shape\_aspect.of\_shape  
{shape\_aspect  
shape\_aspect.description = 'centre'}  
shape\_aspect <=  
shape\_aspect\_relationship.relate\_shape\_aspect]  
[shape\_aspect.of\_shape  
{[shape\_aspect =>  
plant\_item\_connector]  
[shape\_aspect  
shape\_aspect.description = 'end 1']}]  
shape\_aspect <=  
shape\_aspect\_relationship.related\_shape\_aspect]  
shape\_aspect\_relationship =>  
dimensional\_location  
dimensional\_characteristic = dimensional\_location  
dimensional\_characteristic <=  
dimensional\_characteristic\_representation.dimension  
dimensional\_characteristic\_representation  
dimensional\_characteristic\_representation.representation ->  
shape\_dimension\_representation <=  
shape\_representation <=  
{representation  
representation.name = 'y type lateral fitting dimensional shape'}  
representation  
representation.items[i] ->  
{representation\_item  
representation\_item.name = 'centre to end 1 length'})  
#2: (piping\_component\_class <=  
characterized\_object  
characterized\_definition = characterized\_object  
characterized\_definition <=  
property\_definition.definition  
property\_definition  
represented\_definition = property\_definition  
represented\_definition <=

```

property_definition_representation.definition
property_definition_representation
property_definition_representation.used_representation ->
{representation
representation.name = 'y type lateral fitting class dimensions'}
representation
(representation.items[i] ->
{representation_item
(representation_item.name = 'maximum centre to end 1 length')
(representation_item.name = 'minimum centre to end 1 length'}})
([representation.items[i] ->
{representation_item
representation_item.name = 'maximum centre to end 1 length'}])
[representation.items[i] ->
{representation_item
representation_item.name = 'minimum centre to end 1 length'}})]])
representation_item =>
measure_representation_item <=
{measure_with_unit =>
length_measure_with_unit}
measure_with_unit
[measure_with_unit.value_component]
[measure_with_unit.unit_component]

```

### 5.1.9.73.3 centre\_to\_end\_2\_length

#1: The attributes are for an individual piping component.

#2: The attributes are for the definition of a family of piping components.

AIM element: [measure\_with\_unit.value\_component]  
[measure\_with\_unit.unit\_component]

Source: 41

Rules: subtype\_exclusive\_characterized\_object  
subtype\_mandatory\_shape\_representation

Reference path: #1: (piping\_component\_definition <=  
product\_definition  
characterized\_product\_definition = product\_definition  
characterized\_product\_definition  
characterized\_definition = characterized\_product\_definition  
characterized\_definition <=  
property\_definition.definition  
property\_definition =>  
product\_definition\_shape <=  
[shape\_aspect.of\_shape  
{shape\_aspect  
shape\_aspect.description = 'centre'}  
shape\_aspect <=  
shape\_aspect\_relationship.relying\_shape\_aspect]  
[shape\_aspect.of\_shape  
{[shape\_aspect =>

```

plant_item_connector]
[shape_aspect
shape_aspect.description = 'end 2']]
shape_aspect <-
shape_aspect_relationship.related_shape_aspect]
shape_aspect_relationship =>
dimensional_location
dimensional_characteristic = dimensional_location
dimensional_characteristic <-
dimensional_characteristic_representation.dimension
dimensional_characteristic_representation
dimensional_characteristic_representation.representation ->
shape_dimension_representation <=
shape_representation <=
{representation
representation.name = 'y type lateral fitting dimensional shape'}
representation
representation.items[i] ->
{representation_item
representation_item.name = 'centre to end 2 length'}}
#2: (piping_component_class <=
characterized_object
characterized_definition = characterized_object
characterized_definition <-
property_definition.definition
property_definition
represented_definition = property_definition
represented_definition <-
property_definition_representation.definition
property_definition_representation
property_definition_representation.used_representation ->
{representation
representation.name = 'y type lateral fitting class dimensions'}
representation
(representation.items[i] ->
{representation_item
(representation_item.name = 'maximum centre to end 2 length')
(representation_item.name = 'minimum centre to end 2 length'}})
([representation.items[i] ->
{representation_item
representation_item.name = 'maximum centre to end 2 length'}}
[representation.items[i] ->
{representation_item
representation_item.name = 'minimum centre to end 2 length'}})])
representation_item =>
measure_representation_item <=
{measure_with_unit =>
length_measure_with_unit}
measure_with_unit
[measure_with_unit.value_component]
[measure_with_unit.unit_component]

```

**5.1.9.73.4 centre\_to\_end\_3\_length**

#1: The attributes are for an individual piping component.

#2: The attributes are for the definition of a family of piping components.

AIM element: [measure\_with\_unit.value\_component]  
[measure\_with\_unit.unit\_component]

Source: 41

Rules: subtype\_exclusive\_characterized\_object  
subtype\_mandatory\_shape\_representation

Reference path: #1: (piping\_component\_definition <=  
product\_definition  
characterized\_product\_definition = product\_definition  
characterized\_product\_definition  
characterized\_definition = characterized\_product\_definition  
characterized\_definition <=  
property\_definition.definition  
property\_definition =>  
product\_definition\_shape <=  
[shape\_aspect.of\_shape  
{shape\_aspect  
shape\_aspect.description = 'centre'}  
shape\_aspect <=  
shape\_aspect\_relationship.relate\_shape\_aspect]  
[shape\_aspect.of\_shape  
{[shape\_aspect =>  
plant\_item\_connector]  
[shape\_aspect  
shape\_aspect.description = 'end 3']}]  
shape\_aspect <=  
shape\_aspect\_relationship.related\_shape\_aspect]  
shape\_aspect\_relationship =>  
dimensional\_location  
dimensional\_characteristic = dimensional\_location  
dimensional\_characteristic <=  
dimensional\_characteristic\_representation.dimension  
dimensional\_characteristic\_representation  
dimensional\_characteristic\_representation.representation ->  
shape\_dimension\_representation <=  
shape\_representation <=  
{representation  
representation.name = 'y type lateral fitting dimensional shape'}  
representation  
representation.items[i] ->  
{representation\_item  
representation\_item.name = 'centre to end 3 length'}}  
#2: (piping\_component\_class <=  
characterized\_object  
characterized\_definition = characterized\_object  
characterized\_definition <=

```

property_definition.definition
property_definition
represented_definition = property_definition
represented_definition <-
property_definition_representation.definition
property_definition_representation
property_definition_representation.used_representation ->
{representation
representation.name = 'y type lateral fitting class dimensions'}
representation
(representation.items[i] ->
{representation_item
(representation_item.name = 'maximum centre to end 3 length')
(representation_item.name = 'minimum centre to end 3 length'}})
([representation.items[i] ->
{representation_item
representation_item.name = 'maximum centre to end 3 length'}}
[representation.items[i] ->
{representation_item
representation_item.name = 'minimum centre to end 3 length'}}]))
representation_item =>
measure_representation_item <=
{measure_with_unit =>
length_measure_with_unit}
measure_with_unit
[measure_with_unit.value_component]
[measure_with_unit.unit_component]

```

#### 5.1.9.73.5 end\_1\_connector

AIM element: plant\_item\_connector

Source: 227

Reference path:

```

piping_component_definition <=
product_definition
characterized_product_definition = product_definition
characterized_product_definition
characterized_definition = characterized_product_definition
characterized_definition <-
property_definition.definition
property_definition =>
product_definition_shape <-
shape_aspect.of_shape
{shape_aspect
shape_aspect.description = 'end 1'}
shape_aspect =>
plant_item_connector

```

#### 5.1.9.73.6 end\_2\_connector

AIM element: plant\_item\_connector

Source: 227

Reference path: piping\_component\_definition <=  
product\_definition  
characterized\_product\_definition = product\_definition  
characterized\_product\_definition  
characterized\_definition = characterized\_product\_definition  
characterized\_definition <=  
property\_definition.definition  
property\_definition =>  
product\_definition\_shape <=  
shape\_aspect.of\_shape  
{shape\_aspect  
shape\_aspect.description = 'end 2'}  
shape\_aspect =>  
plant\_item\_connector

### 5.1.9.73.7 end\_3\_connector

AIM element: plant\_item\_connector

Source: 227

Reference path: piping\_component\_definition <=  
product\_definition  
characterized\_product\_definition = product\_definition  
characterized\_product\_definition  
characterized\_definition = characterized\_product\_definition  
characterized\_definition <=  
property\_definition.definition  
property\_definition =>  
product\_definition\_shape <=  
shape\_aspect.of\_shape  
{shape\_aspect  
shape\_aspect.description = 'end 3'}  
shape\_aspect =>  
plant\_item\_connector

## 5.1.10 Piping\_inspection UoF

### 5.1.10.1 Connection\_inspection\_record

AIM element: material\_property

Source: 45

Reference path: {material\_property <=  
property\_definition  
property\_definition.description = 'connection inspection record'}

#### 5.1.10.1.1 inspected\_property\_name

AIM element:      property\_definition.name

Source:            41

Reference path:    { material\_property <=  
                      property\_definition  
                      property\_definition.name }

#### **5.1.10.1.2      connection\_type**

AIM element:      group.name

Source:            41

Reference path:    material\_property  
                      classification\_item = material\_property  
                      classification\_item <=  
                      applied\_classification\_assignment.items[i]  
                      applied\_classification\_assignment <=  
                      classification\_assignment  
                      { classification\_assignment.role ->  
                      classification\_role  
                      classification\_role.name = 'connection type' }  
                      classification\_assignment.assigned\_classification ->  
                      group  
                      group.name

#### **5.1.10.1.3      inspection\_type**

AIM element:      group.name

Source:            41

Reference path:    material\_property  
                      classification\_item = material\_property  
                      classification\_item <=  
                      applied\_classification\_assignment.items[i]  
                      applied\_classification\_assignment <=  
                      classification\_assignment  
                      { classification\_assignment.role ->  
                      classification\_role  
                      classification\_role.name = 'inspection type' }  
                      classification\_assignment.assigned\_classification ->  
                      group  
                      group.name

#### **5.1.10.1.4      weld\_id**

AIM element:      identification\_assignment.assigned\_id

Source:            41

Reference path: material\_property  
 identification\_item = material\_property  
 identification\_item <-  
 applied\_identification\_assignment.items[i]  
 applied\_identification\_assignment <=  
 identification\_assignment  
 {identification\_assignment.role ->  
 identification\_role  
 identification\_role.name = 'weld id'}  
 identification\_assignment.assigned\_id

#### 5.1.10.1.5 connecting\_portion\_id

AIM element: identification\_assignment.assigned\_id

Reference path: material\_property  
 identification\_item = document  
 identification\_item <-  
 applied\_identification\_assignment.items[i]  
 applied\_identification\_assignment <=  
 identification\_assignment  
 {identification\_assignment.role ->  
 identification\_role  
 identification\_role.name = 'connecting portion id'}  
 identification\_assignment.assigned\_id

#### 5.1.10.1.6 inspected\_property\_tolerance

AIM element: qualified\_representation\_item

Source: 45

Reference path: material\_property <=  
 property\_definition <-  
 property\_definition\_representation.definition  
 property\_definition\_representation  
 { property\_definition\_representation =>  
 material\_property\_representation}  
 property\_definition\_representation.using\_representation ->  
 representation  
 representation.items[i] ->  
 representation\_item =>  
 {representation\_item.name = 'inspected property tolerance'}  
 qualified\_representation\_item

#### 5.1.10.1.7 inspected\_property\_measured\_value

AIM element: [measure\_with\_unit.value\_component]  
 [measure\_with\_unit.unit\_component]

Source: 41

Reference path:    material\_property <=  
                          property\_definition <-  
                          property\_definition\_representation.definition  
                          property\_definition\_representation  
                          { property\_definition\_representation =>  
                          material\_property\_representation }  
                          property\_definition\_representation.using\_representation ->  
                          representation  
                          representation.items[i] ->  
                          representation\_item =>  
                          { representation\_item.name = 'inspected property measured value' }  
                          measure\_representation\_item  
                          [measure\_with\_unit.value\_component]  
                          [measure\_with\_unit.unit\_component]

### **5.1.10.1.8      connection\_inspection\_record to document**

AIM element:        PATH

Reference path:    material\_property  
                          document\_item = material\_property  
                          document\_item <-  
                          applied\_document\_reference.items[i]  
                          applied\_document\_reference <=  
                          document\_reference  
                          document\_reference.assigned\_document ->  
                          document

### **5.1.10.2      Inspection\_condition**

AIM element:        data\_environment

Source:              45

Reference path:    { data\_environment.description = 'inspection condition' }

#### **5.1.10.2.1      condition\_name**

AIM element:        data\_environment.name

Source:              45

Reference path:    data\_environment  
                          data\_environment.name

#### **5.1.10.2.2      value**

AIM element:        [measure\_representation\_item.value\_component]  
                          [measure\_representation\_item.unit\_component]

Source:              41

Reference path: data\_environment  
data\_environment.elements ->  
property\_definition\_representation  
{property\_definition\_representation.definition ->  
represented\_definition  
represented\_definition = property\_definition  
property\_definition.definition ->  
characterized\_definition  
characterized\_definition = characterized\_object}  
property\_definition\_representation.using\_representation ->  
representation  
representation.items[i] ->  
representation\_item =>  
{representation\_item.name = 'inspection condition value'}  
measure\_representation\_item <=  
measure\_with\_unit  
[measure\_representation\_item.value\_component]  
[measure\_representation\_item.unit\_component]

### 5.1.10.3 Piping\_component\_inspection\_record

AIM element: material\_property  
Source: 45  
Reference path: {material\_property <=  
property\_definition  
property\_definition\_description = 'piping component inspection record'}

#### 5.1.10.3.1 inspected\_property\_name

AIM element: property\_definition.name  
Source: 41  
Reference path: material\_property <=  
property\_definition  
property\_definition.name

#### 5.1.10.3.2 inspected\_property\_tolerance

AIM element: qualified\_representation\_item  
Source: 45  
Reference path: material\_property <=  
property\_definition <=  
property\_definition\_representation.definition  
property\_definition\_representation  
{ property\_definition\_representation =>  
material\_property\_representation}  
property\_definition\_representation.using\_representation ->  
representation

```

representation.items[i] ->
representation_item =>
{representation_item.name = 'inspected property tolerance'}
qualified_representation_item

```

### 5.1.10.3.3 inspected\_property\_measured\_value

AIM element: [measure\_with\_unit.value\_component]  
[measure\_with\_unit.unit\_component]

Source: 41

Reference path: material\_property <=  
property\_definition <=  
property\_definition\_representation.definition  
property\_definition\_representation  
{ property\_definition\_representation =>  
material\_property\_representation}  
property\_definition\_representation.using\_representation ->  
representation  
representation.items[i] ->  
representation\_item =>  
{representation\_item.name = 'inspected property measured value'}  
measure\_representation\_item  
[measure\_with\_unit.value\_component]  
[measure\_with\_unit.unit\_component]

### 5.1.10.3.4 piping\_component\_inspection\_record to piping\_component

NOTE For the purpose of this mapping, only the subset of the mapping of the Piping\_component specified in the reference path is applicable.

AIM element: PATH

Reference path: material\_property <=  
property\_definition  
{property\_definition.description = 'piping component inspection record'}  
property\_definition.definition ->  
characterized\_definition =  
characterized\_product\_definition ->  
product\_definition =>  
piping\_component\_definition

### 5.1.10.3.5 piping\_component\_inspection\_record to plant\_item\_connector

AIM element: PATH

Reference path: material\_property <=  
property\_definition  
{property\_definition.description = 'piping component inspection record'}  
property\_definition.definition ->  
characterized\_definition =  
shape\_definition =

```

shape_aspect =>
plant_item_connector

```

### 5.1.10.3.6 **piping\_component\_inspection\_record to document**

AIM element: PATH

Reference path:

```

material_property
document_item = material_property
document_item <-
applied_document_reference.items[i]
applied_document_reference <=
document_reference
document_reference.assigned_document ->
document

```

### 5.1.10.4 **Piping\_spool\_inspection\_record**

AIM element: material\_property

Source: 45

Reference path:

```

{ material_property <=
property_definition
property_definition.description = 'piping spool inspection record'}

```

#### 5.1.10.4.1 **inspected\_property\_name**

AIM element: property\_definition.name

Source: 41

Reference path:

```

material_property <=
property_definition
property_definition.name

```

#### 5.1.10.4.2 **inspected\_property\_tolerance**

AIM element: qualified\_representation\_item

Source: 45

Reference path:

```

material_property <=
property_definition <-
property_definition_representation.definition
property_definition_representation
{ property_definition_representation =>
material_property_representation}
property_definition_representation.using_representation ->
representation
representation.items[i] ->
representation_item =>

```

```
{representation_item.name = 'inspected property tolerance'}
qualified_representation_item
```

#### 5.1.10.4.3 inspected\_property\_measured\_value

AIM element: [measure\_with\_unit.value\_component]  
[measure\_with\_unit.unit\_component]

Source: 41

Reference path: material\_property <=  
property\_definition <=  
property\_definition\_representation.definition  
property\_definition\_representation  
{ property\_definition\_representation =>  
material\_property\_representation}  
property\_definition\_representation.using\_representation ->  
representation  
representation.items[i] ->  
representation\_item =>  
{representation\_item.name = 'inspected property measured value'}  
measure\_representation\_item  
[measure\_with\_unit.value\_component]  
[measure\_with\_unit.unit\_component]

#### 5.1.10.4.4 piping\_spool\_inspection\_record to piping\_spool

AIM element: PATH

Reference path: material\_property =>  
property\_definition  
{property\_definition.description = 'piping spool inspection record'}  
property\_definition.definition ->  
characterized\_definition =  
characterized\_product\_definition =  
product\_definition =>  
piping\_spool\_definition

#### 5.1.10.4.5 piping\_spool\_inspection\_record to document

AIM element: PATH

Reference path: material\_property  
document\_item = material\_property  
document\_item <=  
applied\_document\_reference.items[i]  
applied\_document\_reference <=  
document\_reference  
document\_reference.assigned\_document ->  
document

**5.1.10.4.6     piping\_spool\_inspection\_record to inspection\_condition**

AIM element:        PATH

Reference path:     material\_property <=  
                          property\_definition <=  
                          {property\_definition.description = 'piping spool inspection record'}  
                          property\_definition\_representation.definition  
                          property\_definition\_representation =>  
                          material\_property\_representation  
                          material\_property\_representation.dependent\_environment ->  
                          data\_environment  
                          {data\_environment.description = 'inspection condition'}

**5.1.10.5     Shape\_inspection\_record**

AIM element:        property\_definition

Source:              41

Reference path:     {property\_definition.description = 'shape inspection record'}

**5.1.10.5.1     shape\_inspection\_property\_name**

AIM element:        property\_definition.name

Source:              41

Reference path:

**5.1.10.5.2     shape\_inspection\_property\_sequence\_number**

AIM element:        descriptive\_representation\_item.description

Source:              45

Reference path:     material\_property <=  
                          property\_definition <=  
                          property\_definition\_representation.definition  
                          property\_definition\_representation  
                          { property\_definition\_representation =>  
                          material\_property\_representation}  
                          property\_definition\_representation.using\_representation ->  
                          representation  
                          representation.items[i] ->  
                          representation\_item =>  
                          {representation\_item.name = 'inspected property sequence number'}  
                          descriptive\_representation\_item  
                          descriptive\_representation\_item.description

**5.1.10.5.3 inspected\_property\_tolerance**

AIM element: qualified\_representation\_item

Source: 45

Reference path: material\_property <=  
property\_definition <=  
property\_definition\_representation.definition  
property\_definition\_representation  
{ property\_definition\_representation =>  
material\_property\_representation}  
property\_definition\_representation.using\_representation ->  
representation  
representation.items[i] ->  
representation\_item =>  
{representation\_item.name = 'inspected property tolerance'}  
qualified\_representation\_item

**5.1.10.5.4 inspected\_property\_measured\_value**

AIM element: [measure\_with\_unit.value\_component]  
[measure\_with\_unit.unit\_component]

Source: 41

Reference path: material\_property <=  
property\_definition <=  
property\_definition\_representation.definition  
property\_definition\_representation  
{ property\_definition\_representation =>  
material\_property\_representation}  
property\_definition\_representation.using\_representation ->  
representation  
representation.items[i] ->  
representation\_item =>  
{representation\_item.name = 'inspected property measured value'}  
measure\_representation\_item  
[measure\_with\_unit.value\_component]  
[measure\_with\_unit.unit\_component]

**5.1.10.5.5 shape\_inspection\_record\_to\_piping\_spool**

AIM element: PATH

Reference path: property\_definition  
{property\_definition.description = 'shape inspection record'}  
property\_definition.definition ->  
characterized\_definition =  
characterized\_product\_definition =  
product\_definition =>  
piping\_spool\_definition

**5.1.10.5.6 shape\_inspection\_record to plant\_item\_connector**

AIM element: PATH

Reference path: property\_definition  
 {property\_definition.description = 'shape inspection record'}  
 property\_definition.definition ->  
 characterized\_definition =  
 shape\_definition =  
 shape\_aspect =>  
 plant\_item\_connector

**5.1.11 Piping\_system\_functional\_characterization UoF****5.1.11.1 Line\_branch\_connection**

AIM element: line\_branch\_connection

Source: 227

Reference path: line\_branch\_connection <=  
 shape\_aspect\_relationship  
 {shape\_aspect\_relationship  
 [shape\_aspect\_relationship.description = 'branch location']  
 [shape\_aspect\_relationship.relate\_shape\_aspect ->  
 shape\_aspect  
 shape\_aspect.of\_shape ->  
 product\_definition\_shape <=  
 property\_definition  
 property\_definition.definition ->  
 characterized\_definition  
 characterized\_definition = characterized\_product\_definition  
 characterized\_product\_definition  
 characterized\_product\_definition = product\_definition  
 product\_definition =>  
 plant\_line\_segment\_definition]  
 [shape\_aspect\_relationship.related\_shape\_aspect ->  
 shape\_aspect =>  
 plant\_line\_segment\_termination]]

**5.1.11.1.1 branch\_sequence\_id**

AIM element: shape\_aspect\_relationship.name

Source: 41

Reference path: line\_branch\_connection <=  
 {shape\_aspect\_relationship  
 shape\_aspect\_relationship.relate\_shape\_aspect ->  
 shape\_aspect  
 shape\_aspect.of\_shape ->  
 product\_definition\_shape <-

```

[shape_aspect.of_shape
shape_aspect
shape_aspect.description = 'termination 1']
[shape_aspect.of_shape
shape_aspect
shape_aspect.description = 'termination 2']]
shape_aspect_relationship
shape_aspect_relationship.name

```

#### **5.1.11.1.2 line\_branch\_connection to changed\_line\_branch\_connection**

AIM element: IDENTICAL MAPPING

#### **5.1.11.2 Line\_branch\_termination**

AIM element: plant\_line\_segment\_termination

Source: 227

Reference path: plant\_line\_segment\_termination <=  
shape\_aspect

#### **5.1.11.2.1 line\_branch\_termination to line\_branch\_connection**

AIM element: PATH

Reference path: plant\_line\_segment\_termination <=  
shape\_aspect <=  
shape\_aspect\_relationship.related\_shape\_aspect  
shape\_aspect\_relationship

#### **5.1.11.3 Line\_piping\_system\_component\_assignment**

AIM element: product\_definition\_relationship

Source: 41

Reference path: {product\_definition\_relationship  
[product\_definition\_relationship.name = 'realization']  
[product\_definition\_relationship.relating\_product\_definition ->  
{product\_definition =>  
plant\_line\_segment\_definition}  
product\_definition  
product\_definition.frame\_of\_reference ->  
product\_definition\_context <=  
application\_context\_element  
application\_context\_element.name = 'functional definition']  
[product\_definition\_relationship.related\_product\_definition ->  
{product\_definition =>  
piping\_component\_definition}  
product\_definition  
product\_definition.frame\_of\_reference ->

```

product_definition_context <=
application_context_element
(application_context_element.name = 'functional occurrence')
(application_context_element.name = 'physical occurrence')]]

```

### 5.1.11.3.1 line\_piping\_system\_component\_assignment to changed\_line\_assignment

AIM element: IDENTICAL MAPPING

### 5.1.11.4 Line\_plant\_item\_branch\_connection

AIM element: line\_plant\_item\_branch\_connection

Source: 227

Reference path: line\_plant\_item\_branch\_connection <=

```

shape_aspect_relationship
{shape_aspect_relationship
[shape_aspect_relationship.relating_shape_aspect ->
shape_aspect
shape_aspect.of_shape ->
product_definition_shape <=
property_definition
property_definition.definition ->
characterized_definition
characterized_definition = characterized_product_definition
characterized_product_definition
characterized_product_definition = product_definition
product_definition =>
plant_line_segment_definition]
[shape_aspect_relationship.related_shape_aspect ->
shape_aspect =>
plant_item_connector]]

```

#### 5.1.11.4.1 branch\_sequence\_id

AIM element: shape\_aspect\_relationship.name

Source: 41

Reference path: line\_plant\_item\_branch\_connection <=

```

{shape_aspect_relationship
shape_aspect_relationship.relating_shape_aspect ->
shape_aspect
shape_aspect.of_shape ->
product_definition_shape <-
[shape_aspect.of_shape
shape_aspect
shape_aspect.description = 'termination 1']
[shape_aspect.of_shape
shape_aspect

```

```

shape_aspect.description = 'termination 2']}
shape_aspect_relationship
shape_aspect_relationship.name

```

#### **5.1.11.4.2 line\_plant\_item\_branch\_connection to changed\_line\_plant\_item\_branch\_connection**

AIM element: IDENTICAL MAPPING

#### **5.1.11.5 Line\_plant\_item\_branch\_connector**

AIM element: plant\_item\_connector

Source: 227

Reference path: plant\_item\_connector <=  
 shape\_aspect  
 { shape\_aspect  
 [shape\_aspect.description = 'line plant item branch connector']  
 [shape\_aspect.of\_shape ->  
 product\_definition\_shape <=  
 property\_definition  
 property\_definition.definition ->  
 characterized\_definition  
 characterized\_definition = characterized\_product\_definition  
 characterized\_product\_definition  
 characterized\_product\_definition = product\_definition  
 product\_definition  
 product\_definition.frame\_of\_reference ->  
 product\_definition\_context <=  
 application\_context\_element  
 application\_context\_element.name = 'functional occurrence']}]

#### **5.1.11.5.1 line\_plant\_item\_branch\_connector to line\_plant\_item\_branch\_connection**

AIM element: PATH

Reference path: plant\_item\_connector <=  
 shape\_aspect <=  
 shape\_aspect\_relationship.related\_shape\_aspect  
 shape\_aspect\_relationship =>  
 line\_plant\_item\_branch\_connection

#### **5.1.11.6 Line\_plant\_item\_connection**

AIM element: line\_plant\_item\_connection

Source: 227

Reference path: line\_plant\_item\_connection <=  
 shape\_aspect\_relationship

```

{shape_aspect_relationship
[shape_aspect_relationship.relate_shape_aspect ->
shape_aspect =>
plant_line_segment_termination]
[shape_aspect_relationship.related_shape_aspect ->
{shape_aspect <=
plant_item_connector}
shape_aspect
shape_aspect.of_shape ->
product_definition_shape <=
property_definition
property_definition.definition ->
characterized_definition
characterized_definition = characterized_product_definition
characterized_product_definition
characterized_product_definition = product_definition
(product_definition)
(product_definition =>
externally_defined_plant_item_definition)}}

```

#### **5.1.11.6.1 line\_plant\_item\_connection to changed\_line\_plant\_item - connection**

AIM element: IDENTICAL MAPPING

#### **5.1.11.7 Line\_plant\_item\_connector**

AIM element: plant\_item\_connector

Source: 227

Reference path: plant\_item\_connector <=

```

shape_aspect
{shape_aspect
[shape_aspect.description = 'line plant item connector']
[shape_aspect.of_shape ->
product_definition_shape <=
property_definition
property_definition.definition ->
characterized_definition
characterized_definition = characterized_product_definition
characterized_product_definition
characterized_product_definition = product_definition
product_definition
product_definition.frame_of_reference ->
product_definition_context <=
application_context_element
application_context_element.name = 'functional occurrence']

```

#### **5.1.11.7.1 line\_plant\_item\_connector to line\_plant\_item\_connection**

AIM element: PATH

Reference path: plant\_item\_connector <=  
 shape\_aspect <=  
 shape\_aspect\_relationship.relate\_shape\_aspect  
 shape\_aspect\_relationship =>  
 line\_plant\_item\_connection

### **5.1.11.8 Line\_plant\_item\_termination**

AIM element: plant\_line\_segment\_termination

Source: 227

Reference path: plant\_line\_segment\_termination <=  
 shape\_aspect

#### **5.1.11.8.1 line\_plant\_item\_termination to line\_plant\_item\_connection**

AIM element: PATH

Reference path: plant\_line\_segment\_termination <=  
 shape\_aspect <=  
 shape\_aspect\_relationship.related\_shape\_aspect  
 shape\_aspect\_relationship =>  
 line\_plant\_item\_connection

### **5.1.11.9 Line\_to\_line\_connection**

AIM element: line\_termination\_connection

Source: 227

Reference path: line\_termination\_connection <=  
 shape\_aspect\_relationship

#### **5.1.11.9.1 line\_to\_line\_connection\_id**

AIM element: shape\_aspect\_relationship.name

Source: 41

Reference path: line\_termination\_connection <=  
 shape\_aspect\_relationship  
 shape\_aspect\_relationship.name

#### **5.1.11.9.2 line\_to\_line\_connection to changed\_line\_to\_line\_connection**

AIM element: IDENTICAL MAPPING

### 5.1.11.9.3 line\_to\_line\_connection to line\_to\_line\_termination

AIM element: PATH

Reference path: line\_termination\_connection <=  
 shape\_aspect\_relationship  
 [shape\_aspect\_relationship.relate\_shape\_aspect ->  
 shape\_aspect =>  
 (connection\_node)  
 (plant\_line\_segment\_termination)]  
 [shape\_aspect\_relationship.related\_shape\_aspect ->  
 shape\_aspect =>  
 plant\_line\_segment\_termination]

### 5.1.11.10 Line\_to\_line\_termination

AIM element: plant\_line\_segment\_termination

Source: 227

Reference path: plant\_line\_segment\_termination <=  
 shape\_aspect

### 5.1.11.11 Piping\_specification

AIM element: document

Source: 41

Reference path: { document  
 document.kind ->  
 document\_type  
 document\_type.product\_data\_type = 'piping specification' }

#### 5.1.11.11.1 name

AIM element: document.name

Source: 41

#### 5.1.11.11.2 owner

AIM element: (organization.name)  
 ([person.first\_name]  
 [person.last\_name])

Source: 41

Reference path: document  
 (plant\_spatial\_configuration\_organization\_item = document  
 plant\_spatial\_configuration\_organization\_item <-  
 plant\_spatial\_configuration\_organization\_assignment.items[i])

```

plant_spatial_configuration_organization_assignment <=
{organization_assignment
organization_assignment.role ->
organization_role
organization_role.name = 'owner'}
organization_assignment
organization_assignment.assigned_organization ->
organization
organization.name)
(plant_spatial_configuration_person_item = document
plant_spatial_configuration_person_item <-
plant_spatial_configuration_person_assignment.items[i]
plant_spatial_configuration_person_assignment <=
{person_assignment
person_assignment.role ->
person_role
person_role.name = 'owner'}
person_assignment
person_assignment.assigned_person ->
person
[person.first_name]
[person.last_name])

```

#### **5.1.11.11.3 piping\_specification\_id**

AIM element: document.id

Source: 41

#### **5.1.11.11.4 service\_description**

AIM element: document\_usage\_constraint

Source: 41

Reference path: document <-  
document\_usage\_constraint.source  
document\_usage\_constraint  
{document\_usage\_constraint  
document\_usage\_constraint.subject\_element = 'service description'}

#### **5.1.11.11.5 piping\_specification to changed\_piping\_specification**

AIM element: IDENTICAL MAPPING

#### **5.1.11.11.6 piping\_specification to family\_definition**

AIM element: PATH

Reference path: document <-  
document\_reference.assigned\_document  
document\_reference =>

```

applied_document_reference
applied_document_reference.items[i] ->
document_item
document_item = piping_component_class
piping_component_class

```

#### 5.1.11.11.7 piping\_specification to piping\_system\_line\_segment

AIM element: PATH

Reference path:

```

document <-
document_reference.assigned_document
document_reference =>
applied_document_reference
applied_document_reference.items[i] ->
document_item
document_item = plant_line_segment_definition
plant_line_segment_definition

```

#### 5.1.11.12 Piping\_system\_line

AIM element: plant\_line\_definition

Source: 227

Reference path:

```

plant_line_definition <=
product_definition_with_associated_documents
{product_definition_with_associated_documents <=
product_definition
product_definition.frame_of_reference ->
product_definition_context <=
application_context_element
application_context_element.name = 'functional definition'}

```

##### 5.1.11.12.1 line\_number

AIM element: product\_definition.description

Source: 41

Reference path:

```

plant_line_definition <=
product_definition_with_associated_documents <=
product_definition
product_definition.description

```

##### 5.1.11.12.2 P\_and\_i\_reference

AIM element: document

Source: 41

Reference path: plant\_line\_definition <=

```

product_definition_with_associated_documents
product_definition_with_associated_documents.documentation_ids[i] ->
document

```

### 5.1.11.12.3 **piping\_system\_line\_id**

AIM element:      product\_definition.id

Source:            41

Reference path:    plant\_line\_definition <=  
                       product\_definition\_with\_associated\_documents <=  
                       product\_definition  
                       product\_definition.id

### 5.1.11.12.4 **piping\_system\_line to changed\_piping\_system\_line**

AIM element:      IDENTICAL MAPPING

### 5.1.11.12.5 **piping\_system\_line to piping\_system\_line\_segment**

AIM element:      PATH

Reference path:    plant\_line\_definition <=  
                       product\_definition\_with\_associated\_documents <=  
                       product\_definition <-  
                       product\_definition\_relationship.relateing\_product\_definition  
                       product\_definition\_relationship  
                       product\_definition\_relationship.related\_product\_definition ->  
                       product\_definition =>  
                       plant\_line\_segment\_definition

### 5.1.11.13 **Piping\_system\_line\_segment**

AIM element:      plant\_line\_segment\_definition

Source:            227

Reference path:    plant\_line\_segment\_definition <=  
                       product\_definition  
                       {product\_definition  
                       product\_definition.frame\_of\_reference ->  
                       product\_definition\_context <=  
                       application\_context\_element  
                       application\_context\_element.name = 'functional definition'}

### 5.1.11.13.1 **coating\_reference**

AIM element:      document\_usage\_constraint

Source:            41

Reference path: plant\_line\_segment\_definition  
 document\_item = plant\_line\_segment\_definition  
 document\_item <-  
 applied\_document\_reference.items[i]  
 applied\_document\_reference <=  
 document\_reference  
 document\_reference.assigned\_document ->  
 document <-  
 document\_usage\_constraint.source  
 document\_usage\_constraint  
 {document\_usage\_constraint  
 document\_usage\_constraint.subject\_element = 'coating reference'}

### 5.1.11.13.2 corrosion\_allowance

AIM element: ([measure\_with\_unit.value\_component]  
 [measure\_with\_unit.unit\_component])  
 ([measure\_with\_unit.value\_component]  
 [measure\_with\_unit.unit\_component]  
 [document\_usage\_constraint.subject\_element\_value])

Source: 41

Reference path: plant\_line\_segment\_definition <=  
 product\_definition  
 characterized\_product\_definition = product\_definition  
 characterized\_product\_definition  
 characterized\_definition = characterized\_product\_definition  
 characterized\_definition <-  
 property\_definition.definition  
 property\_definition  
 represented\_definition = property\_definition  
 represented\_definition <-  
 property\_definition\_representation.definition  
 property\_definition\_representation  
 property\_definition\_representation.used\_representation ->  
 {representation  
 representation.name = 'line segment characteristics'}  
 representation  
 representation.items[i] ->  
 {representation\_item  
 representation\_item.name = 'corrosion allowance'}  
 (representation\_item =>  
 measure\_representation\_item <=  
 measure\_with\_unit  
 [measure\_with\_unit.value\_component]  
 [measure\_with\_unit.unit\_component])  
 ([representation\_item =>  
 measure\_representation\_item <=  
 measure\_with\_unit  
 [measure\_with\_unit.value\_component]  
 [measure\_with\_unit.unit\_component]])  
 [representation\_item  
 document\_item = representation\_item

```

document_item <-
applied_document_reference.items[i]
applied_document_reference <=
document_reference
document_reference.assigned_document ->
document <-
document_usage_constraint
document_usage_constraint.subject_element_value])

```

### 5.1.11.13.3 design\_pressure

AIM element: ([measure\_with\_unit.value\_component]  
[measure\_with\_unit.unit\_component])  
([measure\_with\_unit.value\_component]  
[measure\_with\_unit.unit\_component]  
[document\_usage\_constraint.subject\_element\_value])

Source: 41

Reference path: plant\_line\_segment\_definition <=  
product\_definition  
characterized\_product\_definition = product\_definition  
characterized\_product\_definition  
characterized\_definition = characterized\_product\_definition  
characterized\_definition <-  
property\_definition.definition  
property\_definition  
represented\_definition = property\_definition  
represented\_definition <-  
property\_definition\_representation.definition  
property\_definition\_representation  
property\_definition\_representation.used\_representation ->  
{representation  
representation.name = 'line segment characteristics'}  
representation  
representation.items[i] ->  
{representation\_item  
representation\_item.name = 'design pressure'}  
(representation\_item =>  
measure\_representation\_item <=  
measure\_with\_unit  
[{measure\_with\_unit.value\_component ->  
measure\_value  
measure\_value = ratio\_measure}  
measure\_with\_unit.value\_component]  
[{measure\_with\_unit.unit\_component ->  
unit  
unit = derived\_unit}  
measure\_with\_unit.unit\_component])  
([representation\_item =>  
measure\_representation\_item <=  
measure\_with\_unit  
[{measure\_with\_unit.value\_component ->  
measure\_value

```

measure_value = ratio_measure}
measure_with_unit.value_component]
[measure_with_unit.unit_component ->
unit
unit = derived_unit}
measure_with_unit.unit_component]]
[representation_item
document_item = representation_item
document_item <-
applied_document_reference.items[i]
applied_document_reference <=
document_reference
document_reference.assigned_document ->
document <-
document_usage_constraint
document_usage_constraint.subject_element_value])

```

#### 5.1.11.13.4 design\_temperature

AIM element: ([measure\_with\_unit.value\_component]  
[measure\_with\_unit.unit\_component])  
([measure\_with\_unit.value\_component]  
[measure\_with\_unit.unit\_component]  
[document\_usage\_constraint.subject\_element\_value])

Source: 41

Reference path: plant\_line\_segment\_definition <=  
product\_definition  
characterized\_product\_definition = product\_definition  
characterized\_product\_definition  
characterized\_definition = characterized\_product\_definition  
characterized\_definition <-  
property\_definition.definition  
property\_definition  
represented\_definition = property\_definition  
represented\_definition <-  
property\_definition\_representation.definition  
property\_definition\_representation  
property\_definition\_representation.used\_representation ->  
{representation  
representation.name = 'line segment characteristics'}  
representation  
representation.items[i] ->  
{representation\_item  
representation\_item.name = 'design temperature'}  
(representation\_item =>  
measure\_representation\_item <=  
{measure\_with\_unit =>  
thermodynamic\_temperature\_measure\_with\_unit}  
measure\_with\_unit  
[measure\_with\_unit.value\_component]  
[measure\_with\_unit.unit\_component])  
([representation\_item =>

```

measure_representation_item <=
{measure_with_unit =>
thermodynamic_temperature_measure_with_unit}
measure_with_unit
[measure_with_unit.value_component]
[measure_with_unit.unit_component]]
[representation_item
document_item = representation_item
document_item <-
applied_document_reference.items[i]
applied_document_reference <=
document_reference
document_reference.assigned_document ->
document <-
document_usage_constraint
document_usage_constraint.subject_element_value])

```

### 5.1.11.13.5 elevation

AIM element: [measure\_with\_unit.value\_component]  
[measure\_with\_unit.unit\_component]

Source: 41

Reference path: plant\_line\_segment\_definition <=  
product\_definition  
characterized\_product\_definition = product\_definition  
characterized\_product\_definition  
characterized\_definition = characterized\_product\_definition  
characterized\_definition <-  
property\_definition.definition  
property\_definition  
represented\_definition = property\_definition  
represented\_definition <-  
property\_definition\_representation.definition  
property\_definition\_representation  
property\_definition\_representation.used\_representation ->  
{representation  
representation.name = 'line segment characteristics'}  
representation  
representation.items[i] ->  
{representation\_item  
representation\_item.name = 'elevation'}  
representation\_item =>  
measure\_representation\_item <=  
{measure\_with\_unit =>  
length\_measure\_with\_unit}  
measure\_with\_unit  
[measure\_with\_unit.value\_component]  
[measure\_with\_unit.unit\_component]

**5.1.11.13.6 heat\_tracing\_type**

AIM element: (heat\_tracing\_representation)  
 ([heat\_tracing\_representation]  
 [document\_usage\_constraint.subject\_element\_value])

Source: 227

Reference path: plant\_line\_segment\_definition <=  
 product\_definition  
 characterized\_product\_definition = product\_definition  
 characterized\_product\_definition  
 characterized\_definition = characterized\_product\_definition  
 characterized\_definition <=  
 property\_definition.definition  
 property\_definition  
 represented\_definition = property\_definition  
 represented\_definition <=  
 property\_definition\_representation.definition  
 property\_definition\_representation  
 property\_definition\_representation.used\_representation ->  
 {representation  
 representation.items[i] ->  
 representation\_item =>  
 descriptive\_representation\_item}  
 representation =>  
 (heat\_tracing\_representation)  
 ([heat\_tracing\_representation]  
 [heat\_tracing\_representation  
 document\_item = heat\_tracing\_representation  
 document\_item <=  
 applied\_document\_reference.items[i]  
 applied\_document\_reference <=  
 document\_reference  
 document\_reference.assigned\_document ->  
 document <=  
 document\_usage\_constraint  
 document\_usage\_constraint.subject\_element\_value])  
 41

**5.1.11.13.7 line\_size**

AIM element: shape\_dimension\_representation

Source: 47

Rules: subtype\_mandatory\_shape\_representation

Reference path: plant\_line\_segment\_definition <=  
 product\_definition  
 characterized\_product\_definition = product\_definition  
 characterized\_product\_definition  
 characterized\_definition = characterized\_product\_definition  
 characterized\_definition <=

```

property_definition.definition
{property_definition =>
product_definition_shape}
property_definition
represented_definition = property_definition
represented_definition <-
property_definition_representation.definition
{property_definition_representation =>
shape_definition_representation}
property_definition_representation
property_definition_representation.used_representation ->
{representation
representation.items[i] ->
representation_item
representation_item.name = 'line size'}
representation =>
shape_representation =>
shape_dimension_representation

```

#### **5.1.11.13.8 segment\_id**

AIM element: product\_definition.id

Source: 41

Reference path: plant\_line\_segment\_definition <=  
product\_definition  
product\_definition.id

#### **5.1.11.13.9 piping\_system\_line\_segment to changed\_piping\_system\_line\_segment**

AIM element: IDENTICAL MAPPING

#### **5.1.11.13.10 piping\_system\_line\_segment to line\_branch\_connection**

AIM element: PATH

Reference path: plant\_line\_segment\_definition <=  
product\_definition  
characterized\_product\_definition = product\_definition  
characterized\_product\_definition  
characterized\_definition = characterized\_product\_definition  
characterized\_definition <-  
property\_definition.definition  
property\_definition =>  
product\_definition\_shape <-  
shape\_aspect.of\_shape  
shape\_aspect <-  
shape\_aspect\_relationship.relatng\_shape\_aspect  
shape\_aspect\_relationship =>

line\_branch\_connection

#### **5.1.11.13.11 piping\_system\_line\_segment to line\_plant\_item\_ranch - connection**

AIM element: PATH

Reference path: plant\_line\_segment\_definition <=  
 product\_definition  
 characterized\_product\_definition = product\_definition  
 characterized\_product\_definition  
 characterized\_definition = characterized\_product\_definition  
 characterized\_definition <=  
 property\_definition.definition  
 property\_definition =>  
 product\_definition\_shape <=  
 shape\_aspect.of\_shape  
 shape\_aspect <=  
 shape\_aspect\_relationship.relating\_shape\_aspect  
 shape\_aspect\_relationship =>  
 line\_plant\_item\_branch\_connection

#### **5.1.11.13.12 piping\_system\_line\_segment to line\_piping\_system - component\_assignment**

AIM element: PATH

Reference path: plant\_line\_segment\_definition <=  
 product\_definition <=  
 product\_definition\_relationship.relating\_product\_definition  
 product\_definition\_relationship

#### **5.1.11.13.13 piping\_system\_line\_segment to piping\_system\_line\_segment - termination**

AIM element: PATH

Reference path: plant\_line\_segment\_definition <=  
 product\_definition  
 characterized\_product\_definition = product\_definition  
 characterized\_product\_definition  
 characterized\_definition = characterized\_product\_definition  
 characterized\_definition <=  
 property\_definition.definition  
 property\_definition =>  
 product\_definition\_shape <=  
 shape\_aspect.of\_shape  
 shape\_aspect =>  
 plant\_line\_segment\_termination

**5.1.11.13.14 piping\_system\_line\_segment to segment\_insulation**

AIM element: PATH

Reference path: plant\_line\_segment\_definition <=  
 product\_definition <-  
 product\_definition\_relationship.relateing\_product\_definition  
 product\_definition\_relationship  
 {product\_definition\_relationship  
 product\_definition\_relationship.name = 'segment insulation'}

**5.1.11.13.15 piping\_system\_line\_segment to stream\_design\_case**

AIM element: PATH

Reference path: plant\_line\_segment\_definition <=  
 product\_definition  
 characterized\_product\_definition = product\_definition  
 characterized\_product\_definition  
 characterized\_definition = characterized\_product\_definition  
 characterized\_definition <-  
 property\_definition.definition  
 property\_definition =>  
 stream\_design\_case

**5.1.11.14 Piping\_system\_line\_segment\_termination**

AIM element: plant\_line\_segment\_termination

Source: 227

Reference path: plant\_line\_segment\_termination <=  
 shape\_aspect  
 {[shape\_aspect  
 shape\_aspect.name = 'piping line segment termination']  
 [shape\_aspect <-  
 (shape\_aspect\_relationship.relateing\_shape\_aspect)  
 (shape\_aspect\_relationship.related\_shape\_aspect)  
 shape\_aspect\_relationship =>  
 (line\_branch\_connection)  
 (line\_plant\_item\_connection)  
 (line\_termination\_connection)]  
 [shape\_aspect  
 shape\_aspect.of\_shape ->  
 product\_definition\_shape <=  
 property\_definition  
 property\_definition.definition ->  
 characterized\_definition  
 characterized\_definition = characterized\_product\_definition  
 characterized\_product\_definition  
 characterized\_product\_definition = product\_definition  
 {product\_definition =>  
 plant\_line\_segment\_definition}

```

product_definition
product_definition.frame_of_reference ->
product_definition_context <=
application_context_element
application_context_element.name = 'functional definition']]

```

#### 5.1.11.14.1 flow\_direction

AIM element: descriptive\_representation\_item.description

Source: 45

Reference path:

```

plant_line_segment_termination <=
shape_aspect
shape_definition = shape_aspect
shape_definition
characterized_definition = shape_definition
characterized_definition <-
property_definition.definition
property_definition
represented_definition = property_definition
represented_definition <-
property_definition_representation.definition
property_definition_representation
property_definition_representation.used_representation ->
representation
representation.items[i] ->
{representation_item
representation_item.name = 'flow direction'}
representation_item =>
descriptive_representation_item
descriptive_representation_item.description
{(descriptive_representation_item.description = 'both')
(descriptive_representation_item.description = 'in')
(descriptive_representation_item.description = 'not specified')
(descriptive_representation_item.description = 'out')}

```

#### 5.1.11.14.2 line\_end\_location

AIM element: (point)  
(shape\_aspect)

Source: 41, 42

Reference path:

```

plant_line_segment_termination <=
(shape_aspect
shape_definition = shape_aspect
shape_definition
characterized_definition = shape_definition
characterized_definition <-
property_definition.definition
property_definition
represented_definition = property_definition

```

```

represented_definition <-
property_definition_representation.definition
property_definition_representation
property_definition_representation.used_representation ->
representation
representation.items[i] ->
{representation_item
representation_item.name = 'line end point'}
representation_item =>
geometric_representation_item =>
point)
(shape_aspect <-
shape_aspect_relationship.relate_shape_aspect
shape_aspect_relationship
shape_aspect_relationship.related_shape_aspect ->
{shape_aspect
shape_aspect.name = 'line end location'}
shape_aspect)

```

### 5.1.11.14.3 line\_start\_location

AIM element: (point)  
(shape\_aspect)

Source: 41, 42

Reference path: plant\_line\_segment\_termination <=

```

(shape_aspect
shape_definition = shape_aspect
shape_definition
characterized_definition = shape_definition
characterized_definition <-
property_definition.definition
property_definition
represented_definition = property_definition
represented_definition <-
property_definition_representation.definition
property_definition_representation
property_definition_representation.used_representation ->
representation
representation.items[i] ->
{representation_item
representation_item.name = 'line start point'}
representation_item =>
geometric_representation_item =>
point)
(shape_aspect <-
shape_aspect_relationship.relate_shape_aspect
shape_aspect_relationship
shape_aspect_relationship.related_shape_aspect ->
{shape_aspect
shape_aspect.name = 'line start location'}
shape_aspect)

```

**5.1.11.14.4 termination\_id**

AIM element: shape\_aspect.name

Source: 41

Reference path: plant\_line\_segment\_termination <=  
 shape\_aspect  
 shape\_aspect.name

**5.1.11.14.5 piping\_system\_line\_segment\_termination to changed\_piping\_system\_line\_segment**

AIM element: IDENTICAL MAPPINGtermination

**5.1.11.15 Piping\_system\_line\_termination**

AIM element: plant\_line\_segment\_termination

Source: 227

Reference path: plant\_line\_segment\_termination <=  
 shape\_aspect  
 {[shape\_aspect  
 shape\_aspect.name = 'piping line termination']  
 [shape\_aspect  
 shape\_aspect.of\_shape ->  
 product\_definition\_shape <=  
 property\_definition  
 property\_definition.definition ->  
 characterized\_definition  
 characterized\_definition = characterized\_product\_definition  
 characterized\_product\_definition  
 characterized\_product\_definition = product\_definition\_relationship  
 product\_definition\_relationship  
 [product\_definition\_relationship.related\_product\_definition ->  
 {product\_definition =>  
 plant\_line\_segment\_definition}  
 product\_definition  
 product\_definition.frame\_of\_reference ->  
 product\_definition\_context <=  
 application\_context\_element  
 application\_context\_element.name = 'functional definition']  
 [product\_definition\_relationship.relatng\_product\_definition ->  
 {product\_definition =>  
 product\_definition\_with\_associated\_documents =>  
 plant\_line\_definition}  
 product\_definition  
 product\_definition.frame\_of\_reference ->  
 product\_definition\_context <=  
 application\_context\_element  
 application\_context\_element.name = 'functional definition']]]}

**5.1.11.15.1 location**

AIM element: cartesian\_point

Source: 42

Reference path: plant\_line\_segment\_termination <=  
 shape\_aspect  
 represented\_definition = shape\_aspect  
 represented\_definition <=  
 property\_definition\_representation.definition  
 property\_definition\_representation  
 property\_definition\_representation.used\_representation ->  
 {representation  
 representation.name = 'plant line termination position'}  
 representation  
 representation.items[i] ->  
 representation\_item =>  
 geometric\_representation\_item =>  
 point =>  
 cartesian\_point

**5.1.11.15.2 position\_on\_pipe**

AIM element: descriptive\_representation\_item.description

Source: 45

Reference path: plant\_line\_segment\_termination <=  
 shape\_aspect  
 represented\_definition = shape\_aspect  
 represented\_definition <=  
 property\_definition\_representation.definition  
 property\_definition\_representation  
 property\_definition\_representation.used\_representation ->  
 {representation  
 representation.name = 'plant line termination position'}  
 representation  
 representation.items[i] ->  
 {representation\_item  
 representation\_item.name = 'position on pipe'}  
 representation\_item =>  
 descriptive\_representation\_item  
 descriptive\_representation\_item.description

**5.1.11.15.3 start\_or\_end**

AIM element: descriptive\_representation\_item.description

Source: 45

Reference path: plant\_line\_segment\_termination <=  
 shape\_aspect

```

represented_definition = shape_aspect
represented_definition <-
property_definition_representation.definition
property_definition_representation
property_definition_representation.used_representation ->
{representation
representation.name = 'plant line termination position'}
representation
representation.items[i] ->
{representation_item
representation_item.name = 'start or end'}
representation_item =>
descriptive_representation_item
descriptive_representation_item.description
{(descriptive_representation_item.description = 'start')
(descriptive_representation_item.description = 'end')}

```

#### 5.1.11.15.4 piping\_system\_line\_termination to piping\_system\_line

AIM element: PATH

Reference path: plant\_line\_segment\_termination <=

```

shape_aspect
shape_aspect.of_shape ->
product_definition_shape <=
property_definition
property_definition.definition ->
characterized_definition
characterized_definition = characterized_product_definition
characterized_product_definition
characterized_product_definition = product_definition_relationship
product_definition_relationship
product_definition_relationship.relateing_product_definition ->
{product_definition
product_definition.frame_of_reference ->
product_definition_context <=
application_context_element
application_context_element.name = 'functional definition'}
product_definition =>
product_definition_with_associated_documents =>
plant_line_definition

```

#### 5.1.11.16 Segment\_insulation

AIM element: product\_definition\_relationship

Source: 41

Reference path: {product\_definition\_relationship  
[product\_definition\_relationship.name = 'segment insulation']  
[product\_definition\_relationship.relateing\_product\_definition ->  
product\_definition =>

```
plant_line_segment_definition]]
```

#### 5.1.11.16.1 boundaries

AIM element: descriptive\_representation\_item.description

Source: 45

Reference path: product\_definition\_relationship  
characterized\_product\_definition = product\_definition\_relationship  
characterized\_product\_definition  
characterized\_definition = characterized\_product\_definition  
characterized\_definition <-  
property\_definition.definition  
{property\_definition =>  
product\_definition\_shape}  
property\_definition  
represented\_definition = property\_definition  
represented\_definition <-  
property\_definition\_representation.definition  
{property\_definition\_representation =>  
shape\_definition\_representation}  
property\_definition\_representation  
property\_definition\_representation.used\_representation ->  
{representation  
representation.name = 'segment insulation characteristics'}  
representation  
representation.items[i] ->  
{representation\_item  
representation\_item.name = 'segment insulation boundary'}  
representation\_item <=  
descriptive\_representation\_item  
descriptive\_representation\_item.description

#### 5.1.11.16.2 description

AIM element: product\_definition\_relationship.description

Source: 41

#### 5.1.11.16.3 thickness

AIM element: [measure\_with\_unit.value\_component]  
[measure\_with\_unit.unit\_component]

Source: 41

Reference path: product\_definition\_relationship  
characterized\_product\_definition = product\_definition\_relationship  
characterized\_product\_definition  
characterized\_definition = characterized\_product\_definition  
characterized\_definition <-  
property\_definition.definition

```

{property_definition =>
product_definition_shape}
property_definition
represented_definition = property_definition
represented_definition <-
property_definition_representation.definition
{property_definition_representation =>
shape_definition_representation}
property_definition_representation
property_definition_representation.used_representation ->
{representation
representation.name = 'segment insulation characteristics'}
representation
(representation.items[i] ->
{representation_item
(representation_item.name = 'thickness')
(representation_item.name = 'maximum thickness')
(representation_item.name = 'minimum thickness'}})
([representation.items[i] ->
{representation_item
representation_item.name = 'maximum thickness'}]
[representation.items[i] ->
{representation_item
representation_item.name = 'minimum thickness'}}])
representation_item =>
measure_representation_item <=
{measure_with_unit =>
length_measure_with_unit}
measure_with_unit
[measure_with_unit.value_component]
[measure_with_unit.unit_component]

```

#### 5.1.11.16.4 type

AIM element: product.name

Source: 41

Reference path: product\_definition\_relationship  
product\_definition\_relationship.related\_product\_definition ->  
product\_definition  
product\_definition.formation ->  
product\_definition\_formation  
product\_definition\_formation.of\_product ->  
product  
product.name

#### 5.1.11.17 Stream\_design\_case

AIM element: stream\_design\_case

Source: 227

Reference path: stream\_design\_case <=  
[characterized\_object]  
[property\_definition]

### 5.1.11.17.1 description

AIM element: characterized\_object.description

Source: 41

Rules: subtype\_exclusive\_characterized\_object

Reference path: stream\_design\_case <=  
characterized\_object  
characterized\_object.description

### 5.1.11.17.2 flow\_rate

AIM element: [measure\_with\_unit.value\_component]  
[measure\_with\_unit.unit\_component]

Source: 41

Reference path: stream\_design\_case <=  
property\_definition  
represented\_definition = property\_definition  
represented\_definition <=  
property\_definition\_representation.definition  
property\_definition\_representation  
property\_definition\_representation.used\_representation ->  
{representation  
representation.name = 'stream flow characteristics'}  
representation  
(representation.items[i] ->  
{representation\_item  
(representation\_item.name = 'flow rate')  
(representation\_item.name = 'maximum flow rate')  
(representation\_item.name = 'minimum flow rate'}})  
([representation.items[i] ->  
{representation\_item  
representation\_item.name = 'maximum flow rate'}}]  
[representation.items[i] ->  
{representation\_item  
representation\_item.name = 'minimum flow rate'}}])  
representation\_item =>  
measure\_representation\_item <=  
measure\_with\_unit  
[measure\_with\_unit.value\_component]  
[measure\_with\_unit.unit\_component]

**5.1.11.17.3 pressure**

AIM element: [measure\_with\_unit.value\_component]  
[measure\_with\_unit.unit\_component]

Source: 41

Reference path: stream\_design\_case <=  
property\_definition  
represented\_definition = property\_definition  
represented\_definition <=  
property\_definition\_representation.definition  
property\_definition\_representation  
property\_definition\_representation.used\_representation ->  
{representation  
representation.name = 'stream flow characteristics'}  
representation  
(representation.items[i] ->  
{representation\_item  
(representation\_item.name = 'pressure')  
(representation\_item.name = 'maximum pressure')  
(representation\_item.name = 'minimum pressure'}})  
([representation.items[i] ->  
{representation\_item  
representation\_item.name = 'maximum pressure'}}]  
[representation.items[i] ->  
{representation\_item  
representation\_item.name = 'minimum pressure'}}])  
representation\_item =>  
measure\_representation\_item <=  
measure\_with\_unit  
[{measure\_with\_unit.value\_component ->  
measure\_value  
measure\_value = ratio\_measure}  
measure\_with\_unit.value\_component]  
[{measure\_with\_unit.unit\_component ->  
unit  
unit = derived\_unit}  
measure\_with\_unit.unit\_component]

**5.1.11.17.4 stream\_case\_type**

AIM element: property\_definition.name

Source: 41

Reference path: stream\_design\_case <=  
property\_definition  
property\_definition.name

**5.1.11.17.5 stream\_data\_reference**

AIM element: (descriptive\_representation\_item.description)  
 ([descriptive\_representation\_item.description]  
 [document\_usage\_constraint.subject\_element\_value])

Source: 41, 45

Reference path: stream\_design\_case <=  
 property\_definition  
 represented\_definition = property\_definition  
 represented\_definition <=  
 property\_definition\_representation.definition  
 property\_definition\_representation  
 property\_definition\_representation.used\_representation ->  
 {representation  
 representation.name = 'stream flow characteristics'}  
 representation  
 representation.items[i] ->  
 {representation\_item  
 representation\_item.name = 'stream data reference'}  
 (representation\_item =>  
 descriptive\_representation\_item  
 descriptive\_representation\_item.description)  
 ([representation\_item =>  
 descriptive\_representation\_item  
 descriptive\_representation\_item.description]  
 [representation\_item  
 document\_item = representation\_item  
 document\_item <=  
 applied\_document\_reference.items[i]  
 applied\_document\_reference <=  
 document\_reference  
 document\_reference.assigned\_document ->  
 document <=  
 document\_usage\_constraint  
 document\_usage\_constraint.subject\_element\_value])

**5.1.11.17.6 stream\_design\_id**

AIM element: characterized\_object.name

Source: 41

Rules: subtype\_exclusive\_characterized\_object

Reference path: stream\_design\_case <=  
 characterized\_object  
 characterized\_object.name

**5.1.11.17.7 stream\_design\_case to service\_operating\_case**

AIM element: PATH

Reference path: stream\_design\_case <=  
property\_definition <=  
property\_definition\_relationship.relateing\_property\_definition  
property\_definition\_relationship

#### 5.1.11.17.8 stream\_design\_case to stream\_phase

AIM element: PATH

Rules: subtype\_exclusive\_characterized\_object

Reference path: stream\_design\_case <=  
characterized\_object  
characterized\_definition = characterized\_object  
characterized\_definition <=  
property\_definition.definition  
property\_definition =>  
stream\_phase

#### 5.1.11.18 Stream\_phase

AIM element: stream\_phase

Source: 227

Reference path: stream\_phase <=  
property\_definition

#### 5.1.11.18.1 constituent\_mole\_fraction

AIM element: [measure\_with\_unit.value\_component]  
[measure\_with\_unit.unit\_component]

Source: 41

Reference path: stream\_phase <=  
property\_definition  
represented\_definition = property\_definition  
represented\_definition <=  
property\_definition\_representation.definition  
property\_definition\_representation  
property\_definition\_representation.used\_representation ->  
{representation  
representation.name = 'stream phase characteristics'}  
representation  
representation.items[i] ->  
{representation\_item  
representation\_item.name = 'constituent mole fraction'}  
representation\_item =>  
measure\_representation\_item <=  
{measure\_with\_unit =>

```

ratio_measure_with_unit}
measure_with_unit
[measure_with_unit.value_component]
[measure_with_unit.unit_component]

```

### 5.1.11.18.2 constituents

AIM element: descriptive\_representation\_item.description

Source: 45

Reference path: stream\_phase <=  
property\_definition  
represented\_definition = property\_definition  
represented\_definition <-  
property\_definition\_representation.definition  
property\_definition\_representation  
property\_definition\_representation.used\_representation ->  
{representation  
representation.name = 'stream phase characteristics'}  
representation  
representation.items[i] ->  
{representation\_item  
representation\_item.name = 'constituents'}  
representation\_item =>  
descriptive\_representation\_item  
descriptive\_representation\_item.description

### 5.1.11.18.3 phase\_density

AIM element: [measure\_with\_unit.value\_component]  
[measure\_with\_unit.unit\_component]

Source: 41

Reference path: stream\_phase <=  
property\_definition  
represented\_definition = property\_definition  
represented\_definition <-  
property\_definition\_representation.definition  
property\_definition\_representation  
property\_definition\_representation.used\_representation ->  
{representation  
representation.name = 'stream phase characteristics'}  
representation  
representation.items[i] ->  
{representation\_item  
representation\_item.name = 'phase density'}  
representation\_item =>  
measure\_representation\_item <=  
measure\_with\_unit  
[measure\_with\_unit.value\_component]

[measure\_with\_unit.unit\_component]

#### 5.1.11.18.4 phase\_fraction

AIM element: [measure\_with\_unit.value\_component]  
[measure\_with\_unit.unit\_component]

Source: 41

Reference path: stream\_phase <=  
property\_definition  
represented\_definition = property\_definition  
represented\_definition <=  
property\_definition\_representation.definition  
property\_definition\_representation  
property\_definition\_representation.used\_representation ->  
{representation  
representation.name = 'stream phase characteristics'}  
representation  
representation.items[i] ->  
{representation\_item  
representation\_item.name = 'phase fraction'}  
representation\_item =>  
measure\_representation\_item <=  
{measure\_with\_unit =>  
ratio\_measure\_with\_unit}  
measure\_with\_unit  
[measure\_with\_unit.value\_component]  
[measure\_with\_unit.unit\_component]

#### 5.1.11.18.5 specific\_gravity

AIM element: [measure\_with\_unit.value\_component]  
[measure\_with\_unit.unit\_component]

Source: 41

Reference path: stream\_phase <=  
property\_definition  
represented\_definition = property\_definition  
represented\_definition <=  
property\_definition\_representation.definition  
property\_definition\_representation  
property\_definition\_representation.used\_representation ->  
{representation  
representation.name = 'stream phase characteristics'}  
representation  
representation.items[i] ->  
{representation\_item  
representation\_item.name = 'specific gravity'}  
representation\_item =>  
measure\_representation\_item <=  
measure\_with\_unit

[measure\_with\_unit.value\_component]  
[measure\_with\_unit.unit\_component]

#### 5.1.11.18.6 surface\_tension

AIM element: [measure\_with\_unit.value\_component]  
[measure\_with\_unit.unit\_component]

Source: 41

Reference path: stream\_phase <=  
property\_definition  
represented\_definition = property\_definition  
represented\_definition <=  
property\_definition\_representation.definition  
property\_definition\_representation  
property\_definition\_representation.used\_representation ->  
{representation  
representation.name = 'stream phase characteristics'}  
representation  
representation.items[i] ->  
{representation\_item  
representation\_item.name = 'surface tension'}  
representation\_item =>  
measure\_representation\_item <=  
measure\_with\_unit  
[measure\_with\_unit.value\_component]  
[measure\_with\_unit.unit\_component]

#### 5.1.11.18.7 temperature

AIM element: [measure\_with\_unit.value\_component]  
[measure\_with\_unit.unit\_component]

Source: 41

Reference path: stream\_phase <=  
property\_definition  
represented\_definition = property\_definition  
represented\_definition <=  
property\_definition\_representation.definition  
property\_definition\_representation  
property\_definition\_representation.used\_representation ->  
{representation  
representation.name = 'stream phase characteristics'}  
representation  
(representation.items[i] ->  
{representation\_item  
(representation\_item.name = 'temperature')  
(representation\_item.name = 'maximum temperature')  
(representation\_item.name = 'minimum temperature'))}  
(representation.items[i] ->  
{representation\_item

```

representation_item.name = 'maximum temperature'}}
[representation.items[i] ->
{representation_item
representation_item.name = 'minimum temperature'}})
representation_item =>
measure_representation_item <=
{measure_with_unit =>
thermodynamic_temperature_measure_with_unit}
measure_with_unit
[measure_with_unit.value_component]
[measure_with_unit.unit_component]

```

### 5.1.11.18.8 viscosity

AIM element: [measure\_with\_unit.value\_component]  
[measure\_with\_unit.unit\_component]

Source: 41

Reference path: stream\_phase <=  
property\_definition  
represented\_definition = property\_definition  
represented\_definition <=  
property\_definition\_representation.definition  
property\_definition\_representation  
property\_definition\_representation.used\_representation ->  
{representation  
representation.name = 'stream phase characteristics'}  
representation  
representation.items[i] ->  
{representation\_item  
representation\_item.name = 'viscosity'}  
representation\_item =>  
measure\_representation\_item <=  
measure\_with\_unit  
[measure\_with\_unit.value\_component]  
[measure\_with\_unit.unit\_component]

## 5.1.12 Plant\_characterization UoF

### 5.1.12.1 Cableway\_system

AIM element: cableway\_system

Source: 227

Rules: dependent\_instantiable\_product\_context  
product\_context\_discipline\_type\_constraint  
value\_for\_application\_context

Reference path: cableway\_system <=  
product\_definition

```

{product_definition
product_definition.formation ->
product_definition_formation
product_definition_formation.of_product ->
product
product.frame_of_reference[i] ->
product_context<=
application_context_element
application_context_element.name = 'plant system'}

```

### 5.1.12.2 Ducting\_system

AIM element: ducting\_system

Source: 227

Rules: dependent\_instantiable\_product\_context  
product\_context\_discipline\_type\_constraint  
value\_for\_application\_context

Reference path: ducting\_system <=  
product\_definition  
{product\_definition  
product\_definition.formation ->  
product\_definition\_formation  
product\_definition\_formation.of\_product ->  
product  
product.frame\_of\_reference[i] ->  
product\_context<=  
application\_context\_element  
application\_context\_element.name = 'plant system'}

#### 5.1.12.2.1 type

AIM element: group.name

Source: 41

Reference path: ducting\_system  
classification\_item = ducting\_system  
classification\_item <=  
applied\_classification\_assignment.items[i]  
applied\_classification\_assignment <=  
{classification\_assignment  
classification\_assignment.role ->  
classification\_role  
classification\_role.name = 'ducting system type classification'}  
classification\_assignment  
classification\_assignment.assigned\_classification ->  
{group =>  
system\_class}  
group

group.name

### 5.1.12.2 ducting\_system to stream\_design\_case

AIM element: PATH

Reference path: ducting\_system <=  
 product\_definition  
 characterized\_product\_definition = product\_definition  
 characterized\_product\_definition  
 characterized\_definition = characterized\_product\_definition  
 characterized\_definition <=  
 property\_definition.definition  
 property\_definition =>  
 stream\_design\_case

### 5.1.12.3 Electrical\_system

AIM element: electrical\_system

Source: 227

Rules: dependent\_instantiable\_product\_context  
 product\_context\_discipline\_type\_constraint  
 value\_for\_application\_context

Reference path: electrical\_system <=  
 product\_definition  
 {product\_definition  
 product\_definition.formation ->  
 product\_definition\_formation  
 product\_definition\_formation.of\_product ->  
 product  
 product.frame\_of\_reference[i] ->  
 product\_context<=  
 application\_context\_element  
 application\_context\_element.name = 'plant system'}

### 5.1.12.3.1 system\_voltage\_designation

AIM element: representation

Source: 43

Reference path: electrical\_system <=  
 product\_definition  
 characterized\_product\_definition = product\_definition  
 characterized\_product\_definition  
 characterized\_definition = characterized\_product\_definition  
 characterized\_definition <=  
 property\_definition.definition  
 property\_definition  
 represented\_definition = property\_definition

```

represented_definition <-
property_definition_representation.definition
property_definition_representation
property_definition_representation.used_representation ->
representation
{representation
[representation.name = 'system voltage designation']
[representation.items[i] ->
representation_item =>
measure_representation_item <=
measure_with_unit =>
electric_current_measure_with_unit]}

```

### 5.1.12.3.2 type

AIM element: group.name

Source: 41

Reference path: electrical\_system  
classification\_item = electrical\_system  
classification\_item <-  
applied\_classification\_assignment.items[i]  
applied\_classification\_assignment <=  
{classification\_assignment  
classification\_assignment.role ->  
classification\_role  
classification\_role.name = 'electrical system type classification'}  
classification\_assignment  
classification\_assignment.assigned\_classification ->  
{group =>  
system\_class}  
group  
group.name

### 5.1.12.4 External\_classification

AIM element: externally\_defined\_class

Source: 227

Reference path: externally\_defined\_class <=  
[group]  
[externally\_defined\_item]

#### 5.1.12.4.1 description

AIM element: group.description

Source: 41

Reference path: externally\_defined\_class <=

group  
group.description

#### 5.1.12.4.2 name

AIM element: group.name

Source: 41

Reference path: externally\_defined\_class <=  
group  
group.name

#### 5.1.12.4.3 source

AIM element: external\_source.source\_id

Source: 41

Reference path: externally\_defined\_class <=  
externally\_defined\_item  
externally\_defined\_item.source ->  
(external\_source)  
(external\_source =>  
known\_source)  
external\_source.source\_id

#### 5.1.12.5 Functional\_plant

AIM element: product\_definition

Source: 41

Reference path: {product\_definition  
[product\_definition.formation ->  
product\_definition\_formation  
product\_definition\_formation.of\_product ->  
product =>  
plant]  
[product\_definition.frame\_of\_reference ->  
[product\_definition\_context <=  
application\_context\_element  
application\_context\_element.name = 'functional occurrence']  
[product\_definition\_context  
product\_definition\_context.life\_cycle\_stage = 'functional design']]]}

#### 5.1.12.5.1 functional\_plant to functional\_plant\_satisfaction

AIM element: PATH

Reference path: product\_definition <-  
product\_definition\_relationship.relatating\_product\_definition

```

product_definition_relationship
{product_definition_relationship
product_definition_relationship.name = 'plant satisfaction'}

```

### 5.1.12.5.2 functional\_plant to plant\_system

AIM element: PATH

Reference path: `product_definition <-  
product_definition_relationship.relateing_product_definition  
product_definition_relationship  
product_definition_relationship.related_product_definition ->  
product_definition =>  
(electrical_system)  
(ducting_system)  
(instrumentation_and_control_system)  
(piping_system)  
(structural_system)  
(cableway_system)`

### 5.1.12.6 Functional\_plant\_satisfaction

AIM element: product\_definition\_relationship

Source: 41

Reference path: `{product_definition_relationship  
product_definition_relationship.name = 'plant satisfaction'}`

### 5.1.12.7 Hvac\_system

AIM element: hvac\_system

Source: 227

Rules: `dependent_instantiable_product_context  
product_context_discipline_type_constraint  
value_for_application_context`

Reference path: `hvac_system <=  
product_definition  
{product_definition  
product_definition.formation ->  
product_definition_formation  
product_definition_formation.of_product ->  
product  
product.frame_of_reference[i] ->  
product_context<=  
application_context_element  
application_context_element.name = 'plant system'}`

**5.1.12.8 Instrumentation\_and\_control\_system**

AIM element: instrumentation\_and\_control\_system

Source: 227

Rules: dependent\_instantiable\_product\_context  
product\_context\_discipline\_type\_constraint  
value\_for\_application\_context

Reference path: instrumentation\_and\_control\_system <=  
product\_definition  
{product\_definition  
product\_definition.formation ->  
product\_definition\_formation  
product\_definition\_formation.of\_product ->  
product  
product.frame\_of\_reference[i] ->  
product\_context<=  
application\_context\_element  
application\_context\_element.name = 'plant system'}

**5.1.12.8.1 type**

AIM element: group.name

Source: 41

Reference path: instrumentation\_and\_control\_system  
classification\_item = instrumentation\_and\_control\_system  
classification\_item <=  
applied\_classification\_assignment.items[i]  
applied\_classification\_assignment <=  
{classification\_assignment  
classification\_assignment.role ->  
classification\_role  
classification\_role.name = 'instrumentation and control system type \ classification'}  
classification\_assignment  
classification\_assignment.assigned\_classification ->  
{group =>  
system\_class}  
group  
group.name

**5.1.12.9 Line\_less\_piping\_system**

AIM element: line\_less\_piping\_system

Source: 227

Rules: dependent\_instantiable\_product\_context  
product\_context\_discipline\_type\_constraint  
value\_for\_application\_context

Reference path: line\_less\_piping\_system <=  
 product\_definition  
 {product\_definition  
 product\_definition.formation ->  
 product\_definition\_formation  
 product\_definition\_formation.of\_product ->  
 product  
 product.frame\_of\_reference[i] ->  
 product\_context<=  
 application\_context\_element  
 application\_context\_element.name = 'plant system'}

#### 5.1.12.9.1 line\_less\_piping\_system to piping\_system\_component

AIM element: PATH

Reference path: line\_less\_piping\_system <=  
 product\_definition <-  
 product\_definition\_relationship.relateing\_product\_definition  
 {product\_definition\_relationship =>  
 product\_definition\_usage =>  
 assembly\_component\_usage}  
 product\_definition\_relationship  
 product\_definition\_relationship.related\_product\_definition ->  
 product\_definition =>  
 piping\_component\_definition

#### 5.1.12.9.2 line\_less\_piping\_system to stream\_design\_case

AIM element: PATH

Reference path: line\_less\_piping\_system <=  
 product\_definition  
 characterized\_product\_definition = product\_definition  
 characterized\_product\_definition  
 characterized\_definition = characterized\_product\_definition  
 characterized\_definition <-  
 property\_definition.definition  
 property\_definition =>  
 stream\_design\_case

#### 5.1.12.10 Location\_in\_plant

AIM element: (axis2\_placement\_2d)  
 (axis2\_placement\_3d)

Source: 42

Reference path: {(axis2\_placement\_2d <=)  
 (axis2\_placement\_3d <=)  
 placement <=  
 geometric\_representation\_item <=}

```

representation_item <-
representation.items[i]
{representation =>
shape_representation}
representation <-
property_definition_representation.used_representation
{property_definition_representation =>
shape_definition_representation}
property_definition_representation
property_definition_representation.definition ->
represented_definition
represented_definition = property_definition
{property_definition =>
product_definition_shape}
property_definition
property_definition.definition ->
characterized_definition
characterized_definition = characterized_product_definition
characterized_product_definition
characterized_product_definition = product_definition
{product_definition
product_definition.frame_of_reference ->
product_definition_context <=
application_context_element
application_context_element.name = 'physical occurrence'}
product_definition
product_definition.formation ->
product_definition_formation
product_definition_formation.of_product ->
product =>
plant}

```

#### 5.1.12.11 Manufacturing\_line

AIM element:	plant
Source:	227
Rules:	dependent_instantiable_product_context product_context_discipline_type_constraint value_for_application_context
Reference path:	plant <= product {product product.frame_of_reference[i] -> product_context <= application_context_element application_context_element.name = 'manufacturing line'}

#### 5.1.12.12 Piping\_system

AIM element:      piping\_system

Source:            227

Rules:             dependent\_instantiable\_product\_context  
                      product\_context\_discipline\_type\_constraint  
                      value\_for\_application\_context

Reference path:    piping\_system <=  
                      product\_definition  
                      {product\_definition  
                      product\_definition.formation ->  
                      product\_definition\_formation  
                      product\_definition\_formation.of\_product ->  
                      product  
                      product.frame\_of\_reference[i] ->  
                      product\_context<=  
                      application\_context\_element  
                      application\_context\_element.name = 'plant system'}

#### **5.1.12.12.1    code**

AIM element:      document\_usage\_constraint.subject\_element\_value

Source:            41

Reference path:    piping\_system  
                      document\_item = piping\_system  
                      document\_item <=  
                      applied\_document\_reference.items[i]  
                      applied\_document\_reference <=  
                      document\_reference  
                      document\_reference.assigned\_document ->  
                      document <=  
                      document\_usage\_constraint.source  
                      document\_usage\_constraint  
                      document\_usage\_constraint.subject\_element\_value  
                      {document\_usage\_constraint.subject\_element = 'piping system code'}

#### **5.1.12.12.2    description**

AIM element:      product\_definition\_formation.description

Source:            41

Reference path:    piping\_system <=  
                      product\_definition  
                      product\_definition.formation ->  
                      product\_definition\_formation  
                      product\_definition\_formation.description

**5.1.12.12.3 approval\_state**

AIM element: approval\_status.name

Source: 41

Reference path: piping\_system  
 piping\_system = approval\_item  
 approval\_item <-  
 applied\_approval\_assignment.items[i]  
 applied\_approval\_assignment <=  
 approval\_assignment  
 approval\_assignment.assigned\_approval ->  
 approval  
 approval.status ->  
 approval\_status  
 approval\_status.name

**5.1.12.12.4 piping\_system to piping\_system\_line**

AIM element: PATH

Reference path: piping\_system <=  
 product\_definition <-  
 product\_definition\_relationship.relating\_product\_definition  
 product\_definition\_relationship  
 product\_definition\_relationship.related\_product\_definition ->  
 product\_definition =>  
 product\_definition\_with\_associated\_documents =>  
 plant\_line\_definition

**5.1.12.13 Planned\_physical\_plant**

AIM element: product\_definition

Source: 41

Reference path: {product\_definition  
 [product\_definition.formation ->  
 product\_definition\_formation  
 product\_definition\_formation.of\_product ->  
 product =>  
 plant]  
 [product\_definition.frame\_of\_reference ->  
 [product\_definition\_context <=  
 application\_context\_element  
 application\_context\_element.name = 'physical occurrence']  
 [product\_definition\_context  
 product\_definition\_context.life\_cycle\_stage = 'physical design']]}

**5.1.12.13.1 planned\_physical\_plant to changed\_planned\_physical\_plant**

AIM element: IDENTICAL MAPPING

### 5.1.12.13.2 **planned\_physical\_plant to functional\_plant\_satisfaction**

AIM element: PATH

Reference path: `product_definition <-  
product_definition_relationship.related_product_definition  
product_definition_relationship  
{product_definition_relationship  
product_definition_relationship.name = 'plant satisfaction'}`

### 5.1.12.13.3 **planned\_physical\_plant to location\_in\_plant**

AIM element: PATH

Rules: `subtype_mandatory_shape_representation`

Reference path: `product_definition  
characterized_product_definition = product_definition  
characterized_product_definition  
characterized_definition = characterized_product_definition  
characterized_definition <-  
property_definition.definition  
{property_definition =>  
product_definition_shape}  
property_definition  
represented_definition = property_definition  
represented_definition <-  
property_definition_representation.definition  
{property_definition_representation =>  
shape_definition_representation}  
property_definition_representation  
property_definition_representation.used_representation ->  
{representation =>  
shape_representation}  
representation  
representation.items[i] ->  
representation_item =>  
geometric_representation_item =>  
placement =>  
(axis2_placement_2d)  
(axis2_placement_3d)`

### 5.1.12.13.4 **planned\_physical\_plant to sited\_plant**

AIM element: PATH

Reference path: `product_definition  
characterized_product_definition = product_definition  
characterized_product_definition  
characterized_definition = characterized_product_definition  
characterized_definition <-`

```

property_definition.definition
property_definition =>
sited_plant

```

### 5.1.12.14 Plant

AIM element: plant

Source: 227

Reference path:

```

plant <=
product
{product <-
product_definition_formation.of_product
product_definition_formation <-
product_definition.formation
product_definition
product_definition.frame_of_reference ->
product_definition_context
(product_definition_context.life_cycle_stage = 'physical design')
(product_definition_context.life_cycle_stage = 'functional design')}

```

#### 5.1.12.14.1 definition\_coordinate\_system

AIM element: representation\_context.context\_identifier

Source: 43

Reference path:

```

plant <=
product <-
product_definition_formation.of_product
product_definition_formation <-
product_definition.formation
product_definition
characterized_product_definition = product_definition
characterized_product_definition
characterized_definition = characterized_product_definition
characterized_definition <-
property_definition.definition
property_definition
represented_definition = property_definition
represented_definition <-
property_definition_representation.definition
property_definition_representation
property_definition_representation.used_representation ->
{representation
representation.items[i] ->
[representation_item
representation_item.name = 'plant placement reference']
[representation_item =>
geometric_representation_item =>
placement =>
((axis2_placment_2d

```

```

axis2_placement_2d.ref_direction ->
direction <=
geometric_representation_item <=
representation_item
(representation_item.name = 'plant north')
(representation_item.name = 'forward perpendicular')
(representation_item.name = 'aft perpendicular'))
(axis2_placement_2d))
((axis2_placement_3d
axis2_placement_3d.axis ->
direction <=
geometric_representation_item <=
representation_item
(representation_item.name = 'plant north')
(representation_item.name = 'forward perpendicular')
(representation_item.name = 'aft perpendicular'))
(axis2_placement_3d.ref_direction ->
direction <=
geometric_representation_item <=
representation_item
(representation_item.name = 'plant north')
(representation_item.name = 'forward perpendicular')
(representation_item.name = 'aft perpendicular'))
(axis2_placement_3d)))}}
representation
representation.context_of_items ->
{representation_context =>
geometric_representation_context}
representation_context
representation_context.context_identifier

```

#### 5.1.12.14.2 description

AIM element: product.description

Source: 41

Reference path: plant <=
product
product.description

#### 5.1.12.14.3 name

AIM element: product.name

Source: 41

Reference path: plant <=
product
product.name

**5.1.12.14.4 operator**

AIM element: (organization)  
(person\_and\_organization)

Source: 41

Reference path: plant  
 (plant\_spatial\_configuration\_organization\_item = plant  
 plant\_spatial\_configuration\_organization\_item <-  
 plant\_spatial\_configuration\_organization\_assignment.items[i]  
 plant\_spatial\_configuration\_organization\_assignment <=  
 {organization\_assignment  
 organization\_assignment.role ->  
 organization\_role  
 organization\_role.name = 'plant operator'}  
 organization\_assignment  
 organization\_assignment.assigned\_organization ->  
 organization)  
 (plant\_spatial\_configuration\_person\_and\_organization\_item = plant  
 plant\_spatial\_configuration\_person\_and\_organization\_item <-  
 plant\_spatial\_configuration\_person\_and\_organization\_assignment.items[i]  
 plant\_spatial\_configuration\_person\_and\_organization\_assignment <=  
 {person\_and\_organization\_assignment  
 person\_and\_organization\_assignment.role ->  
 person\_and\_organization\_role  
 person\_and\_organization\_role.name = 'plant operator'}  
 person\_and\_organization\_assignment  
 person\_and\_organization\_assignment.assigned\_person\_and\_organization ->  
 person\_and\_organization)

**5.1.12.14.5 owners**

AIM element: (person)  
(organization)  
(person\_and\_organization)

Source: 41

Reference path: plant  
 (plant\_spatial\_configuration\_person\_item = plant  
 plant\_spatial\_configuration\_person\_item <-  
 plant\_spatial\_configuration\_person\_assignment.items[i]  
 plant\_spatial\_configuration\_person\_assignment <=  
 {person\_assignment  
 person\_assignment.role ->  
 person\_role  
 person\_role.name = 'plant owner'}  
 person\_assignment  
 person\_assignment.assigned\_person ->  
 person)  
 (plant\_spatial\_configuration\_organization\_item = plant  
 plant\_spatial\_configuration\_organization\_item <-  
 plant\_spatial\_configuration\_organization\_assignment.items[i]

```

plant_spatial_configuration_organization_assignment <=
{organization_assignment
organization_assignment.role ->
organization_role
organization_role.name = 'plant owner'}
organization_assignment
organization_assignment.assigned_organization ->
organization)
(plant_spatial_configuration_person_and_organization_item = plant
plant_spatial_configuration_person_and_organization_item <-
plant_spatial_configuration_person_and_organization_assignment.items[i]
plant_spatial_configuration_person_and_organization_assignment <=
{person_and_organization_assignment
person_and_organization_assignment.role ->
person_and_organization_role
person_and_organization_role.name = 'plant owner'}
person_and_organization_assignment
person_and_organization_assignment.assigned_person_and_organization ->
person_and_organization)

```

#### 5.1.12.14.6 **plant\_id**

AIM element:      product.id

Source:            41

Reference path:    plant <=

                      product

                      product.id

#### 5.1.12.14.7 **length\_between\_perpendiculars**

AIM element:      [measure\_with\_unit.value\_component]

                      [measure\_with\_unit.unit\_component]

Source:            41

Reference path:    plant <=

                      product <-

                      product\_definition\_formation.of\_product

                      product\_definition\_formation <-

                      product\_definition.formation

                      product\_definition

                      characterized\_product\_definition = product\_definition

                      characterized\_product\_definition

                      characterized\_definition = characterized\_product\_definition

                      characterized\_definition <-

                      property\_definition.definition

                      property\_definition <-

                      property\_definition\_representation.definition

                      property\_definition\_representation

                      property\_definition\_representation.using\_representation ->

                      representation

```

representation.items[i] ->
representation_item =>
{representation_item.name = 'length between perpendiculars '}
measure_representation_item <=
{measure_with_unit =>
length_measure_with_unit}
measure_with_unit
[measure_with_unit.value_component]
[measure_with_unit.unit_component]

```

#### 5.1.12.14.8 plant\_type

AIM element: group.name

Source: 41

Reference path:

```

product
classification_item = product
classification_item <-
applied_classification_assignment.items[i]
applied_classification_assignment <=
{classification_assignment
classification_assignment.role ->
classification_role
classification_role.name = 'plant type classification'}
classification_assignment
classification_assignment.assigned_classification ->
group
group.name

```

#### 5.1.12.14.9 plant to changed\_plant

AIM element: IDENTICAL MAPPING

#### 5.1.12.14.10 plant to external\_classification

AIM element: PATH

Reference path:

```

plant <=
product
classification_item = product
classification_item <-
applied_classification_assignment.items[i]
applied_classification_assignment <=
classification_assignment
classification_assignment.assigned_classification ->
group =>
externally_defined_class

```

#### 5.1.12.14.11 plant to functional\_plant

AIM element: PATH

Rules: application\_context\_requires\_ap\_definition  
dependent\_instantiable\_application\_context  
dependent\_instantiable\_product\_definition\_context  
product\_definition\_context\_name\_constraint

Reference path: plant <=  
product <=  
product\_definition\_formation.of\_product  
product\_definition\_formation <=  
product\_definition.formation  
product\_definition  
{product\_definition  
product\_definition.frame\_of\_reference ->  
product\_definition\_context <=  
application\_context\_element  
application\_context\_element.name = 'functional occurrence'}

#### 5.1.12.14.12 plant to planned\_physical\_plant

AIM element: PATH

Rules: application\_context\_requires\_ap\_definition  
dependent\_instantiable\_application\_context  
dependent\_instantiable\_product\_definition\_context  
product\_definition\_context\_name\_constraint  
product\_definition\_usage\_constraint

Reference path: plant <=  
product <=  
product\_definition\_formation.of\_product  
product\_definition\_formation <=  
product\_definition.formation  
product\_definition  
{product\_definition  
product\_definition.frame\_of\_reference ->  
product\_definition\_context <=  
application\_context\_element  
application\_context\_element.name = 'physical occurrence'}

#### 5.1.12.14.13 plant to plant\_process\_capability

AIM element: PATH

Reference path: plant <=  
product <=  
product\_definition\_formation.of\_product  
product\_definition\_formation <=  
product\_definition.formation  
product\_definition  
characterized\_product\_definition = product\_definition  
characterized\_product\_definition

```

characterized_definition = characterized_product_definition
characterized_definition <-
property_definition.definition
property_definition =>
process_capability

```

#### 5.1.12.14.14 plant to sub\_plant\_relationship (contains)

AIM element: PATH

Reference path:

```

plant <=
product <-
product_definition_formation.of_product
product_definition_formation <-
product_definition.formation
product_definition <-
product_definition_relationship.relatng_product_definition
product_definition_relationship
{product_definition_relationship
product_definition_relationship.name = 'sub plant'}

```

#### 5.1.12.14.15 plant to sub\_plant\_relationship (used in)

AIM element: PATH

Reference path:

```

plant <=
product <-
product_definition_formation.of_product
product_definition_formation <-
product_definition.formation
product_definition <-
product_definition_relationship.related_product_definition
product_definition_relationship
{product_definition_relationship
product_definition_relationship.name = 'sub plant'}

```

#### 5.1.12.15 Plant\_process\_capability

AIM element: process\_capability

Source: 227

Reference path:

```

process_capability <=
property_definition

```

##### 5.1.12.15.1 plant\_process\_capability\_id

AIM element: property\_definition.name

Source: 41

Reference path:

```

process_capability <=

```

property\_definition  
property\_definition.name

#### 5.1.12.15.2 production\_capacity

AIM element: representation

Source: 43

Reference path: process\_capability <=  
property\_definition  
represented\_definition = property\_definition  
represented\_definition <=  
property\_definition\_representation.definition  
property\_definition\_representation  
property\_definition\_representation.used\_representation ->  
representation  
{representation  
representation.name = 'production capacity'}

#### 5.1.12.15.3 production\_type

AIM element: descriptive\_representation\_item.description

Source: 45

Reference path: process\_capability <=  
property\_definition  
represented\_definition = property\_definition  
represented\_definition <=  
property\_definition\_representation.definition  
property\_definition\_representation  
property\_definition\_representation.used\_representation ->  
{representation  
representation.name = 'production capacity'}  
representation  
representation.items[i] ->  
{representation\_item  
representation\_item.name = 'production type'}  
representation\_item =>  
descriptive\_representation\_item  
descriptive\_representation\_item.description

#### 5.1.12.15.4 plant\_process\_capability to changed\_plant\_process\_capability

AIM element: IDENTICAL MAPPING

#### 5.1.12.16 Plant\_system

AIM element: (electrical\_system)  
(ducting\_system)  
(instrumentation\_and\_control\_system)

(piping\_system)  
 (structural\_system)  
 (cableway\_system)

Source: 227

Rules: dependent\_instantiable\_product\_context  
 product\_context\_discipline\_type\_constraint  
 value\_for\_application\_context

Reference path: (electrical\_system <=)  
 (ducting\_system <=)  
 (instrumentation\_and\_control\_system <=)  
 (piping\_system <=)  
 (structural\_system <=)  
 (cableway\_system <=)  
 product\_definition  
 {product\_definition  
 product\_definition.formation ->  
 product\_definition\_formation  
 product\_definition\_formation.of\_product ->  
 product  
 product.frame\_of\_reference[i] ->  
 product\_context<=  
 application\_context\_element  
 application\_context\_element.name = 'plant system'}  
 227  
 227

#### 5.1.12.16.1 name

AIM element: product\_definition.description

Source: 41

Reference path: (electrical\_system <=)  
 (ducting\_system <=)  
 (instrumentation\_and\_control\_system <=)  
 (piping\_system <=)  
 (structural\_system <=)  
 (cableway\_system <=)  
 product\_definition  
 product\_definition.description

#### 5.1.12.16.2 plant\_system\_id

AIM element: product\_definition.id

Source: 41

Reference path: (electrical\_system <=)  
 (ducting\_system <=)  
 (instrumentation\_and\_control\_system <=)

```
(piping_system <=)
(structural_system <=)
(cableway_system <=)
product_definition
product_definition.id
```

### 5.1.12.16.3 service\_description

AIM element: property\_definition.name

Source: 41

Reference path:

```
(electrical_system <=)
(ducting_system <=)
(instrumentation_and_control_system <=)
(piping_system <=)
(structural_system <=)
(cableway_system <=)
product_definition
characterized_product_definition = product_definition
characterized_product_definition
characterized_definition = characterized_product_definition
characterized_definition <-
property_definition.definition
property_definition
property_definition.name
```

### 5.1.12.16.4 plant\_system to changed\_plant\_system

AIM element: IDENTICAL MAPPING

### 5.1.12.16.5 plant\_system to external\_classification

AIM element: PATH

Reference path:

```
(electrical_system
classification_item = electrical_system)
(ducting_system
classification_item = ducting_system)
(instrumentation_and_control_system
classification_item = instrumentation_and_control_system)
(piping_system
classification_item = piping_system)
(structural_system
classification_item = structural_system)
(cableway_system
classification_item = cableway_system)
classification_item <-
applied_classification_assignment.items[i]
applied_classification_assignment <=
classification_assignment
classification_assignment.assigned_classification ->
```

group =>  
externally\_defined\_class

#### 5.1.12.16.6 plant\_system to plant\_item

AIM element: PATH

Reference path: (electrical\_system <=)  
(ducting\_system <=)  
(instrumentation\_and\_control\_system <=)  
(piping\_system <=)  
(structural\_system <=)  
(cableway\_system <=)  
product\_definition <-  
product\_definition\_relationship.relying\_product\_definition  
product\_definition\_relationship  
product\_definition\_relationship.related\_product\_definition ->  
(product\_definition)  
(product\_definition =>  
externally\_defined\_plant\_item\_definition)  
(product\_definition  
product\_definition.formation ->  
product\_definition\_formation  
product\_definition\_formation.of\_product ->  
product)

#### 5.1.12.16.7 plant\_system to plant\_system\_assembly (sub-system)

AIM element: PATH

Reference path: (electrical\_system <=)  
(ducting\_system <=)  
(instrumentation\_and\_control\_system <=)  
(piping\_system <=)  
(structural\_system <=)  
(cableway\_system <=)  
product\_definition <-  
product\_definition\_relationship.related\_product\_definition  
product\_definition\_relationship  
product\_definition\_relationship.relying\_product\_definition ->  
product\_definition  
(electrical\_system)  
(ducting\_system)  
(instrumentation\_and\_control\_system)  
(piping\_system)  
(structural\_system)  
(cableway\_system)

#### 5.1.12.16.8 plant\_system to plant\_system\_assembly (super-system)

AIM element: PATH

Reference path: (electrical\_system <=)  
 (ducting\_system <=)  
 (instrumentation\_and\_control\_system <=)  
 (piping\_system <=)  
 (structural\_system <=)  
 (cableway\_system <=)  
 product\_definition <-  
 product\_definition\_relationship.relating\_product\_definition  
 product\_definition\_relationship  
 product\_definition\_relationship.related\_product\_definition ->  
 product\_definition  
 (electrical\_system)  
 (ducting\_system)  
 (instrumentation\_and\_control\_system)  
 (piping\_system)  
 (structural\_system)  
 (cableway\_system)

#### 5.1.12.17 Plant\_system\_assembly

AIM element: (electrical\_system)  
 (ducting\_system)  
 (instrumentation\_and\_control\_system)  
 (piping\_system)  
 (structural\_system)  
 (cableway\_system)

Source: 227

Reference path: (electrical\_system <=)  
 (ducting\_system <=)  
 (instrumentation\_and\_control\_system <=)  
 (piping\_system <=)  
 (structural\_system <=)  
 (cableway\_system <=)  
 product\_definition  
 227  
 227

#### 5.1.12.18 Structural\_system

AIM element: structural\_system

Source: 227

Rules: dependent\_instantiable\_product\_context  
 product\_context\_discipline\_type\_constraint  
 value\_for\_application\_context

Reference path: structural\_system <=  
 product\_definition  
 {product\_definition  
 product\_definition.formation ->

```

product_definition_formation
product_definition_formation.of_product ->
product
product.frame_of_reference[i] ->
product_context<=
application_context_element
application_context_element.name = 'plant system'}

```

### 5.1.12.18.1 type

AIM element: group.name

Source: 41

Reference path: structural\_system  
classification\_item = structural\_system  
classification\_item <-  
applied\_classification\_assignment.items[i]  
applied\_classification\_assignment <=  
{classification\_assignment  
classification\_assignment.role ->  
classification\_role  
classification\_role.name = 'structural system type classification'}  
classification\_assignment  
classification\_assignment.assigned\_classification ->  
{group =>  
system\_class}  
group  
group.name

### 5.1.12.19 Sub\_plant\_relationship

AIM element: product\_definition\_relationship

Source: 41

Reference path: {product\_definition\_relationship  
product\_definition\_relationship.name = 'sub plant'}

### 5.1.12.19.1 location\_and\_orientation

AIM element: (axis2\_placement\_2d)  
(axis2\_placement\_3d)

Source: 42

Rules: subtype\_mandatory\_shape\_representation

Reference path: product\_definition\_relationship  
characterized\_product\_definition = product\_definition\_relationship  
characterized\_product\_definition  
characterized\_definition = characterized\_product\_definition  
characterized\_definition <-

```

property_definition.definition
{property_definition =>
product_definition_shape}
property_definition
represented_definition = property_definition
represented_definition <-
property_definition_representation.definition
property_definition_representation
property_definition_representation.used_representation ->
{representation =>
shape_representation}
representation
representation.items[i] ->
representation_item =>
geometric_representation_item =>
placement =>
(axis2_placement_2d)
(axis2_placement_3d)

```

### 5.1.12.19.2 sub\_plant\_relationship to changed\_sub\_plant\_relationship

AIM element: IDENTICAL MAPPING

### 5.1.12.20 Train

AIM element: plant

Source: 227

Rules: dependent\_instantiable\_product\_context  
product\_context\_discipline\_type\_constraint  
value\_for\_application\_context

Reference path: plant <=  
product  
{product  
product.frame\_of\_reference[i] ->  
product\_context <=  
application\_context\_element  
application\_context\_element.name = 'train'}

### 5.1.12.21 Unit

AIM element: plant

Source: 227

Rules: dependent\_instantiable\_product\_context  
product\_context\_discipline\_type\_constraint  
value\_for\_application\_context

Reference path: plant <=  
product

```
{product
product.frame_of_reference[i] ->
product_context <=
application_context_element
application_context_element.name = 'unit'}
```

### 5.1.13 Plant\_csg\_shape\_representation UoF

#### 5.1.13.1 Block

AIM element: block

Source: 42

#### 5.1.13.2 Circular\_ellipsoid

AIM element: ellipsoid

Source: 42

#### 5.1.13.3 Cone

AIM element: right\_circular\_cone

Source: 42

#### 5.1.13.4 Csg\_element

AIM element: (csg\_primitive)  
(boolean\_result)  
faceted\_brep  
(plant\_design\_csg\_primitive)

Source: 42, 227

#### 5.1.13.5 Cylinder

AIM element: right\_circular\_cylinder

Source: 42

#### 5.1.13.6 Eccentric\_cone

AIM element:  
eccentric\_cone

Source: 42

### 5.1.13.7 Eccentric\_cylinder

AIM element:

`eccentric_cone`

Source:

42

Reference path:

`{eccentric_cone  
eccentric_cone.ratio = 1 }`

### 5.1.13.8 Eccentric\_pyramid

AIM element:

`rectangular_pyramid`

Source:

42

### 5.1.13.9 Extrusion

AIM element:

`extruded_area_solid`

Source:

42

Reference path:

`{extruded_area_solid <=  
swept_area_solid  
swept_area_solid.swept_area ->  
curve_bounded_surface  
[curve_bounded_surface.basis_surface ->  
surface =>  
elementary_surface =>  
plane]  
[curve_bounded_surface.boundaries[i] ->  
surface_boundary  
surface_boundary = boundary_curve  
boundary_curve <=  
composite_curve_on_surface <=  
composite_curve  
composite_curve.segments[i] ->  
composite_curve_segment  
composite_curve_segment.parent_curve ->  
surface_curve  
surface_curve.curve_3d ->  
curve =>  
bounded_curve =>  
trimmed_curve  
trimmed_curve.basis_curve ->  
curve =>  
(line)  
(conic)]}`

### 5.1.13.10 Faceted\_brep

AIM element:

`faceted_brep`

Source: 42

#### 5.1.13.11 Hemisphere

AIM element: plant\_design\_csg\_primitive

Source: 227

Reference path: plant\_design\_csg\_primitive <=  
[ { solid\_model <=  
geometric\_representation\_item <=  
representation\_item  
representation\_item.name = 'hemisphere' }  
solid\_model ]  
[ { shape\_representation <=  
representation  
representation.name = 'hemisphere' }  
shape\_representation ]

#### 5.1.13.12 Pyramid

AIM element: rectangular\_pyramid

Source: 42

#### 5.1.13.13 Reducing\_torus

AIM element:  
cyclide\_segment\_solid

Source: 42

#### 5.1.13.14 Solid\_of\_revolution

AIM element: revolved\_area\_solid

Source: 42

Reference path: { revolved\_area\_solid <=  
swept\_area\_solid  
swept\_area\_solid.swept\_area ->  
curve\_bounded\_surface  
curve\_bounded\_surface.boundaries[i] ->  
surface\_boundary  
surface\_boundary = boundary\_curve  
boundary\_curve <=  
composite\_curve\_on\_surface <=  
composite\_curve  
composite\_curve.segments[i] ->  
composite\_curve\_segment  
composite\_curve\_segment.parent\_curve ->  
surface\_curve

```

surface_curve.curve_3d ->
curve =>
bounded_curve =>
trimmed_curve
trimmed_curve.basis_curve ->
curve =>
(line)
(conic)}

```

### 5.1.13.15 Sphere

AIM element: sphere

Source: 42

### 5.1.13.16 Square\_to\_round

AIM element: plant\_design\_csg\_primitive

Source: 42

Reference path: plant\_design\_csg\_primitive <=  
 [{solid\_model <=  
 geometric\_representation\_item <=  
 representation\_item  
 representation\_item.name = 'rectangle to ellipse'  
 solid\_model]  
 [{shape\_representation <=  
 representation  
 representation.name = 'rectangle to ellipse'}  
 shape\_representation]

### 5.1.13.17 Torus

AIM element: torus

Source: 42

### 5.1.13.18 Trimmed\_block

AIM element: plant\_design\_csg\_primitive

Source: 227

Reference path: plant\_design\_csg\_primitive <=  
 [{solid\_model <=  
 geometric\_representation\_item <=  
 representation\_item  
 representation\_item.name = 'trimmed block'  
 solid\_model]  
 [{shape\_representation <=  
 representation

```
representation.name = 'trimmed block'}
shape_representation]
```

### 5.1.13.19 Trimmed\_cone

AIM element: eccentric\_cone

Source: 42

Reference path: {eccentric\_cone  
eccentric\_cone.semi\_axis\_1 = eccentric\_cone.semi\_axis\_2}

### 5.1.13.20 Trimmed\_cylinder

AIM element: eccentric\_cone

Source: 42

### 5.1.13.21 Trimmed\_pyramid

AIM element: plant\_design\_csg\_primitive

Source: 227

Reference path: plant\_design\_csg\_primitive <=  
[ {solid\_model <=  
geometric\_representation\_item <=  
representation\_item  
representation\_item.name = 'trimmed pyramid'}  
solid\_model]  
[ {shape\_representation <=  
representation  
representation.name = 'trimmed pyramid'}  
shape\_representation]

### 5.1.13.22 Trimmed\_sphere

AIM element: plant\_design\_csg\_primitive

Source: 227

Reference path: plant\_design\_csg\_primitive <=  
[ {solid\_model <=  
geometric\_representation\_item <=  
representation\_item  
representation\_item.name = 'trimmed sphere'}  
solid\_model]  
[ {shape\_representation <=  
representation  
representation.name = 'trimmed sphere'}  
shape\_representation]

### 5.1.13.23 Trimmed\_torus

AIM element: cyclide\_segment\_solid

Source: 42

## 5.1.14 Plant\_item\_characterization UoF

### 5.1.14.1 Analysis\_data\_point

AIM element: shape\_aspect

Source: 41

Reference path: { shape\_aspect  
shape\_aspect.description = 'analysis data point' }

#### 5.1.14.1.1 id

AIM element: identification\_assignment.assigned\_id

Source: 41

Reference path: identification\_item = shape\_aspect  
identification\_item <-  
applied\_identification\_assignment.items[i]  
applied\_identification\_assignment <=  
identification\_assignment  
{ identification\_assignment.role ->  
identification\_role  
identification\_role.name = 'analysis data point id' }  
identification\_assignment.assigned\_id

#### 5.1.14.1.2 name

AIM element: shape\_aspect.name

Source: 41

#### 5.1.14.1.3 location

AIM element: (axis2\_placement\_2d)  
(axis2\_placement\_3d)

Source: 42

Reference path: shape\_aspect  
shape\_definition = shape\_aspect  
shape\_definition  
characterized\_definition = shape\_definition  
characterized\_definition <-  
property\_definition.definition

```

property_definition
represented_definition = property_definition
represented_definition <-
property_definition_representation.definition
property_definition_representation
property_definition_representation.used_representation ->
representation
representation.items[i] ->
{representation_item
representation_item.name = 'analysis data point location'}
representation_item =>
geometric_representation_item =>
placement =>
(axis2_placement_2d)
(axis2_placement_3d)

```

### 5.1.14.2 Bolt

AIM element: bolt\_and\_nut\_component\_definition

Source: 227

Rules: dependent\_instantiable\_product\_context  
product\_context\_discipline\_type\_constraint  
value\_for\_application\_context

Reference path: bolt\_and\_nut\_component\_definition <=  
product\_definition  
{bolt\_and\_nut\_component\_definition  
classification\_item = piping\_support\_definition  
classification\_item <=  
applied\_classification\_assignment.items[i]  
applied\_classification\_assignment <=  
classification\_assignment  
classification\_assignment.assigned\_classification ->  
[group =>  
bolt\_and\_nut\_component\_class]  
[group  
group.name = 'bolt']}  
{product\_definition  
product\_definition.formation ->  
product\_definition\_formation  
product\_definition\_formation.of\_product ->  
[product  
classification\_item = product  
classification\_item <=  
applied\_classification\_assignment.items[i]  
applied\_classification\_assignment <=  
classification\_assignment  
classification\_assignment.assigned\_classification ->  
(group)  
(group <=  
group\_relationship.related\_group  
group\_relationship

```

group_relationship.relatng_group ->
group)
group.name = 'bolt and nut component']
[product
product.frame_of_reference[i] ->
product_context <=
application_context_element
application_context_element.name = 'plant item']})

```

#### 5.1.14.2.1 bolt\_type

AIM element: group.name

Source: 41

Reference path: bolt\_and\_nut\_component\_definition  
classification\_item = piping\_support\_definition  
classification\_item <-  
applied\_classification\_assignment.items[i]  
applied\_classification\_assignment <=  
classification\_assignment  
classification\_assignment.assigned\_classification ->  
group <-  
{[group =>  
bolt\_and\_nut\_component\_class]  
[group  
group.name = 'bolt']}  
group\_relationship.relatng\_group  
group\_relationship  
{group\_relationship.name = 'class hierarchy'}  
group\_relationship.related\_group ->  
group  
{group =>  
bolt\_and\_nut\_component\_class}  
group.name

#### 5.1.14.3 Clamp

AIM element: product

Source: 41

Rules: dependent\_instantiable\_product\_context  
product\_context\_discipline\_type\_constraint  
value\_for\_application\_context

Reference path: {[product  
classification\_item = product  
classification\_item <-  
applied\_classification\_assignment.items[i]  
applied\_classification\_assignment <=  
classification\_assignment  
classification\_assignment.assigned\_classification ->

```

[group
group.name = 'clamp']
[group
group_relationship.related_group
group_relationship
{group_relationship.name = 'usage classification'}
group_relationship.relying_group ->
group
group.name = 'connection component']]
[product
product.frame_of_reference[i] ->
product_context <=
application_context_element
application_context_element.name = 'plant item']]

```

#### 5.1.14.4 Bolt\_and\_nut\_component

AIM element: product

Source: 41

Rules: dependent\_instantiable\_product\_context  
product\_context\_discipline\_type\_constraint  
value\_for\_application\_context

Reference path: {[product  
classification\_item = product  
classification\_item <-  
applied\_classification\_assignment.items[i]  
applied\_classification\_assignment <=  
classification\_assignment  
classification\_assignment.assigned\_classification ->  
[group  
group.name = 'bolt and nut component']  
[group  
group\_relationship.related\_group  
group\_relationship  
{group\_relationship.name = 'usage classification'}  
group\_relationship.relying\_group ->  
group  
group.name = 'connection component']]  
[product  
product.frame\_of\_reference[i] ->  
product\_context <=  
application\_context\_element  
application\_context\_element.name = 'plant item']]}

##### 5.1.14.4.1 nominal\_size

AIM element: [measure\_with\_unit.value\_component]  
[measure\_with\_unit.unit\_component]

Source: 41

Reference path: product <-  
 product\_definition\_formation.of\_product  
 product\_definition\_formation <-  
 product\_definition.formation  
 product\_definition  
 characterized\_product\_definition = product\_definition  
 characterized\_product\_definition  
 characterized\_definition = characterized\_product\_definition  
 characterized\_definition <-  
 property\_definition.definition  
 property\_definition <-  
 property\_definition\_representation.definition  
 property\_definition\_representation  
 property\_definition\_representation.using\_representation ->  
 representation  
 { representation.name = 'connection component size'}  
 representation  
 representation.items[i] ->  
 representation\_item =>  
 {representation\_item.name = 'nominal size'}  
 measure\_representation\_item <=  
 {measure\_with\_unit =>  
 length\_measure\_with\_unit}  
 measure\_with\_unit  
 [measure\_with\_unit.value\_component]  
 [measure\_with\_unit.unit\_component]

#### 5.1.14.4.2 quantity

AIM element: [measure\_with\_unit.value\_component]  
 [measure\_with\_unit.unit\_component]

Source: 41

Reference path: product <-  
 product\_definition\_formation.of\_product  
 product\_definition\_formation <-  
 product\_definition.formation  
 product\_definition  
 {product\_definition =>  
 bolt\_and\_nut\_component\_definition}  
 product\_definition <-  
 product\_definition\_relationship.related\_product\_definition  
 product\_definition\_relationship =>  
 {product\_definition\_relationship.relatating\_product\_definition ->  
 product\_definition =>  
 bolt\_and\_nut\_set\_definition}  
 product\_definition\_usage =>  
 assembly\_component\_usage =>  
 quantified\_assembly\_component\_usage  
 quantified\_assembly\_component\_usage.quantity ->  
 measure\_with\_unit

```
{measure_with_unit =>
count_measure_with_unit}
[measure_with_unit.value_component]
[measure_with_unit.unit_component]
```

### 5.1.14.5 Bolt\_and\_nut\_set

AIM element: bolt\_and\_nut\_set\_definition

Source: 227

Reference path: bolt\_and\_nut\_set\_definition <=  
product\_definition

#### 5.1.14.5.1 set\_id

AIM element: product\_definition.id

Reference path: bolt\_and\_nut\_set\_definition <=  
product\_definition  
product\_definition.id

#### 5.1.14.5.2 quantity\_used

AIM element: [measure\_with\_unit.value\_component]  
[measure\_with\_unit.unit\_component]

Source: 41

Reference path: bolt\_and\_nut\_set\_definition <=  
product\_definition <-  
product\_definition\_relationship.related\_product\_definition  
product\_definition\_relationship =>  
{product\_definition\_relationship.relatating\_product\_definition ->  
product\_definition =>  
connection\_material\_definition}  
product\_definition\_usage =>  
assembly\_component\_usage =>  
quantified\_assembly\_component\_usage  
quantified\_assembly\_component\_usage.quantity ->  
measure\_with\_unit  
{measure\_with\_unit =>  
count\_measure\_with\_unit}  
[measure\_with\_unit.value\_component]  
[measure\_with\_unit.unit\_component]

#### 5.1.14.5.3 bolt\_and\_nut\_set to connection\_material

AIM element: PATH

Reference path: bolt\_and\_nut\_set\_definition <=  
product\_definition <-

```

product_definition_relationship.related_product_definition
product_definition_relationship
{product_definition_relationship =>
product_definition_usage =>
(assembly_component_usage)
(assembly_component_usage =>
quantified_assembly_component_usage)}}
product_definition_relationship.relatng_product_definition ->
product_definition =>
connection_material_definition

```

#### 5.1.14.5.4 bolt\_and\_nut\_set to bolt\_and\_nut\_component

AIM element: PATH

Reference path: bolt\_and\_nut\_set\_definition <=  
product\_definition <-  
product\_definition\_relationship.relatng\_product\_definition  
product\_definition\_relationship  
{product\_definition\_relationship =>  
product\_definition\_usage =>  
(assembly\_component\_usage)  
(assembly\_component\_usage =>  
quantified\_assembly\_component\_usage)}}  
product\_definition\_relationship.related\_product\_definition ->  
product\_definition =>  
bolt\_and\_nut\_component\_definition

#### 5.1.14.6 Clamp\_set

AIM element: clamp\_set\_definition

Source: 227

Reference path: clamp\_set\_definition <=  
product\_definition

##### 5.1.14.6.1 set\_id

AIM element: product\_definition.id

Reference path: clamp\_set\_definition <=  
product\_definition  
product\_definition.id

##### 5.1.14.6.2 quantity

AIM element: [measure\_with\_unit.value\_component]  
[measure\_with\_unit.unit\_component]

Source: 41

Reference path: clamp\_set\_definition <=  
product\_definition <=  
product\_definition\_relationship.related\_product\_definition  
product\_definition\_relationship =>  
{product\_definition\_relationship.relateing\_product\_definition ->  
product\_definition =>  
connection\_material\_definition}  
product\_definition\_usage =>  
assembly\_component\_usage =>  
quantified\_assembly\_component\_usage  
quantified\_assembly\_component\_usage.quantity ->  
measure\_with\_unit  
{measure\_with\_unit =>  
count\_measure\_with\_unit}  
[measure\_with\_unit.value\_component]  
[measure\_with\_unit.unit\_component]

### 5.1.14.6.3 clamp\_set to connection\_material

AIM element: PATH

Reference path clamp\_set\_definition <=  
product\_definition <=  
product\_definition\_relationship.related\_product\_definition  
product\_definition\_relationship  
{product\_definition\_relationship =>  
product\_definition\_usage =>  
(assembly\_component\_usage)  
(assembly\_component\_usage =>  
quantified\_assembly\_component\_usage)}  
product\_definition\_relationship.relateing\_product\_definition ->  
product\_definition =>  
connection\_material\_definition

### 5.1.14.6.4 clamp\_set to clamp

AIM element: PATH

Reference path: clamp\_set\_definition <=  
product\_definition <=  
product\_definition\_relationship.relateing\_product\_definition  
product\_definition\_relationship  
{product\_definition\_relationship =>  
product\_definition\_usage =>  
(assembly\_component\_usage)  
(assembly\_component\_usage =>  
quantified\_assembly\_component\_usage)}  
product\_definition\_relationship.related\_product\_definition ->  
product\_definition =>  
clamp\_component\_definition

### 5.1.14.6.5 clamp\_set to bolt\_and\_nut\_component

AIM element: PATH

Reference path: clamp\_set\_definition <=  
 product\_definition <=  
 product\_definition\_relationship.relateing\_product\_definition  
 product\_definition\_relationship  
 {product\_definition\_relationship =>  
 product\_definition\_usage =>  
 (assembly\_component\_usage)  
 (assembly\_component\_usage =>  
 quantified\_assembly\_component\_usage)}  
 product\_definition\_relationship.related\_product\_definition ->  
 product\_definition =>  
 bolt\_and\_nut\_component\_definition

### 5.1.14.7 Cable\_support

AIM element: product

Source: 41

Rules: dependent\_instantiable\_product\_context  
 product\_context\_discipline\_type\_constraint  
 value\_for\_application\_context

Reference path: {[product  
 classification\_item = product  
 classification\_item <=  
 applied\_classification\_assignment.items[i]  
 applied\_classification\_assignment <=  
 classification\_assignment  
 classification\_assignment.assigned\_classification ->  
 [group  
 group.name = 'cable support']  
 [group <=  
 group\_relationship.related\_group  
 {group\_relationship  
 group\_relationship.name = 'usage classification'}  
 group\_relationship  
 group\_relationship.relateing\_group ->  
 group  
 group.name = 'support component']]  
 [product  
 product.frame\_of\_reference[i] ->  
 product\_context<=  
 application\_context\_element  
 application\_context\_element.name = 'plant item']]

### 5.1.14.7.1 cable\_support\_type

AIM element: group.name

Source: 41

Reference path: product  
classification\_item = product  
classification\_item <-  
applied\_classification\_assignment.items[i]  
applied\_classification\_assignment <=  
{classification\_assignment  
classification\_assignment.role ->  
classification\_role  
classification\_role.name = 'cable support type classification'}  
classification\_assignment  
classification\_assignment.assigned\_classification ->  
group  
group.name

### 5.1.14.8 Catalogue\_definition

AIM element: catalogue

Source: 227

Reference path: catalogue <=  
(external\_source)  
(external\_source =>  
known\_source)  
[document]

#### 5.1.14.8.1 catalogue\_id

AIM element: document.id

Source: 41

Reference path: catalogue <=  
document  
document.id

#### 5.1.14.8.2 catalogue\_name

AIM element: document.name

Source: 41

Reference path: catalogue <=  
document  
document.name

#### 5.1.14.8.3 catalogue\_version

AIM element: document.description

Source: 41

Reference path: catalogue <=  
document  
document.description

#### **5.1.14.8.4 catalogue\_definition to catalogue\_connector**

AIM element: PATH

Rules: subtype\_mandatory\_pre\_defined\_item

Reference path: catalogue <=  
(external\_source)  
(external\_source =>  
known\_source) <=  
externally\_defined\_item.source  
externally\_defined\_item =>  
catalogue\_connector

#### **5.1.14.8.5 catalogue\_definition to catalogue\_item**

AIM element: PATH

Rules: subtype\_mandatory\_pre\_defined\_item

Reference path: catalogue <=  
(external\_source)  
(external\_source =>  
known\_source) <=  
externally\_defined\_item.source  
externally\_defined\_item =>  
externally\_defined\_plant\_item\_definition =>  
catalogue\_item

#### **5.1.14.9 Catalogue\_item**

AIM element: catalogue\_item

Source: 227

Reference path: catalogue\_item <=  
externally\_defined\_plant\_item\_definition <=  
[product\_definition  
{product\_definition  
product\_definition.frame\_of\_reference ->  
product\_definition\_context <=  
application\_context\_element  
application\_context\_element.name = 'physical definition'}]  
[externally\_defined\_item  
{externally\_defined\_item

```

externally_defined_item.source ->
  (external_source)
  (external_source =>
    known_source) =>
  catalogue}]

```

#### 5.1.14.9.1 item\_name

AIM element: product.name

Source: 41

Reference path: catalogue\_item <=  
 externally\_defined\_plant\_item\_definition <=  
 product\_definition  
 product\_definition.formation ->  
 product\_definition\_formation  
 product\_definition\_formation.of\_product ->  
 product  
 product.name

#### 5.1.14.9.2 item\_version

AIM element: product\_definition\_formation.id

Source: 41

Reference path: catalogue\_item <=  
 externally\_defined\_plant\_item\_definition <=  
 product\_definition  
 product\_definition.formation ->  
 product\_definition\_formation  
 product\_definition\_formation.id

#### 5.1.14.9.3 model\_number

AIM element: product.id

Source: 41

Reference path: catalogue\_item <=  
 externally\_defined\_plant\_item\_definition <=  
 product\_definition  
 product\_definition.formation ->  
 product\_definition\_formation  
 product\_definition\_formation.of\_product ->  
 product  
 product.id

#### 5.1.14.9.4 catalogue\_item to catalogue\_item\_substitute (has as substitute)

AIM element: PATH

Reference path: catalogue\_item <=  
externally\_defined\_plant\_item\_definition <=  
product\_definition <=  
product\_definition\_relationship.related\_product\_definition  
product\_definition\_relationship <=  
product\_definition\_substitute.context\_relationship  
product\_definition\_substitute

#### **5.1.14.9.5 catalogue\_item to catalogue\_item\_substitute (is substitute)**

AIM element: PATH

Reference path: catalogue\_item <=  
externally\_defined\_plant\_item\_definition <=  
product\_definition <=  
product\_definition\_substitute.substitute\_definition  
product\_definition\_substitute

#### **5.1.14.9.6 catalogue\_item to plant\_item\_definition (is defined by)**

AIM element: PATH

Reference path: catalogue\_item <=  
externally\_defined\_plant\_item\_definition

#### **5.1.14.10 Catalogue\_item\_substitute**

AIM element: product\_definition\_substitute

Source: 41

#### **5.1.14.11 Connected\_collection**

AIM element: assembly\_component\_usage

Source: 44

Reference path: {assembly\_component\_usage <=  
product\_definition\_usage <=  
product\_definition\_relationship  
(product\_definition\_relationship.name = 'connected collection')  
(product\_definition\_relationship.name = 'connected hierarchical collection')}

#### **5.1.14.11.1 connected\_collection to plant\_item\_connection**

AIM element: PATH

Reference path: assembly\_component\_usage <=  
product\_definition\_usage <=  
product\_definition\_relationship

```

product_definition_relationship.relatng_product_definition ->
product_definition
characterized_product_definition = product_definition
characterized_product_definition
characterized_definition = characterized_product_definition
characterized_definition <-
property_definition.definition
property_definition =>
product_definition_shape <-
shape_aspect.of_shape
shape_aspect =>
plant_item_connection

```

#### 5.1.14.12 Connection\_component

AIM element: product

Source: 41

Rules: dependent\_instantiable\_product\_context  
product\_context\_discipline\_type\_constraint  
value\_for\_application\_context

Reference path: {[product  
classification\_item = product  
classification\_item <-  
applied\_classification\_assignment.items[i]  
applied\_classification\_assignment <=  
classification\_assignment  
classification\_assignment.assigned\_classification ->  
group  
group.name = 'connection component']  
[product  
product.frame\_of\_reference[i] ->  
product\_context<=  
application\_context\_element  
application\_context\_element.name = 'plant item']]}

#### 5.1.14.13 Connection\_material

AIM element: connection\_material\_definition

Source: 227

Reference path: connection\_material\_definition <=  
product\_definition

##### 5.1.14.13.1 material\_name

AIM element: material\_designation.name

Source: 45

Reference path: connection\_material\_definition <=  
product\_definition  
characterized\_product\_definition = product\_definition  
characterized\_product\_definition  
characterized\_definition = characterized\_product\_definition  
characterized\_definition <=  
property\_definition.definition  
property\_definition =>  
product\_definition\_shape <=  
shape\_aspect.of\_shape  
shape\_aspect =>  
plant\_item\_connection <=  
shape\_aspect\_relationship  
shape\_aspect\_relationship  
shape\_definition = shape\_aspect\_relationship  
shape\_definition  
characterized\_definition = shape\_definition  
characterized\_definition <=  
material\_designation.definitions[i]  
material\_designation  
material\_designation.name

#### **5.1.14.14 Design\_project**

AIM element: design\_project

Source: 227

Reference path: design\_project <=  
organization

##### **5.1.14.14.1 description**

AIM element: organization.description

Source: 41

Reference path: design\_project <=  
organization  
organization.description

##### **5.1.14.14.2 design\_project\_id**

AIM element: organization.id

Source: 41

Reference path: design\_project <=  
organization  
organization.id

**5.1.14.14.3 name**

AIM element: organization.name

Source: 41

Reference path: design\_project <=  
organization  
organization.name

**5.1.14.14.4 owner**

AIM element: organization.name

Source: 41

Reference path: design\_project  
plant\_spatial\_configuration\_organization\_item = design\_project  
plant\_spatial\_configuration\_organization\_item <-  
plant\_spatial\_configuration\_organization\_assignment.items[i]  
plant\_spatial\_configuration\_organization\_assignment <=  
{organization\_assignment  
organization\_assignment.role ->  
organization\_role  
organization\_role.name = 'project owner'}  
organization\_assignment  
organization\_assignment.assigned\_organization ->  
organization  
organization.name

**5.1.14.14.5 design\_project to project\_design\_assignment**

AIM element: PATH

Reference path: design\_project <=  
organization <-  
organization\_assignment.assigned\_organization  
organization\_assignment =>  
design\_project\_assignment

**5.1.14.15 Document**

AIM element: document

Source: 41

Reference path

**5.1.14.15.1 document\_id**

AIM element: document.id

Source: 41

Reference path: document  
document.id

#### **5.1.14.15.2 version\_id**

AIM element: identification\_assignment.assigned\_id

Source: 41

Reference path: document  
identification\_item = document  
identification\_item <-  
applied\_identification\_assignment.items[i]  
applied\_identification\_assignment <=  
identification\_assignment  
{identification\_assignment.role ->  
identification\_role  
identification\_role.name = 'document version id'}  
identification\_assignment.assigned\_id

#### **5.1.14.15.3 document\_type**

AIM element: document\_type.product\_data\_type

Source: 41

Reference path: document  
document.kind ->  
document\_type  
document\_type.product\_data\_type

#### **5.1.14.15.4 internal\_document\_reference**

AIM element: [document\_usage\_constraint.subject\_element]  
[document\_usage\_constraint.subject\_element\_value]

Source: 41

Reference path: document <-  
document\_usage\_constraint.source  
document\_usage\_constraint  
[document\_usage\_constraint.subject\_element]  
[document\_usage\_constraint.subject\_element\_value]

#### **5.1.14.15.5 document to plant\_item**

#1: The whole document is associated with the plant\_item

#2: Part of the document is associated with the plant\_item

AIM element: PATH

Reference path: document  
 #1: (document <-  
 document\_usage\_constraint.source  
 document\_usage\_constraint <-  
 document\_usage\_constraint\_assignment.assigned\_document\_usage  
 document\_usage\_constraint\_assignment =>  
 applied\_document\_usage\_constraint\_assignment  
 applied\_document\_usage\_constraint\_assignment.items[i] ->  
 document\_usage\_constraint\_item=  
 (product\_definition)  
 (externally\_defined\_plant\_item\_definition)  
 (product))  
 #2: (document <-  
 document\_reference.assigned\_document  
 document\_reference =>  
 applied\_document\_reference  
 applied\_document\_reference.items[i] ->  
 document\_item =  
 (product\_definition)  
 (externally\_defined\_plant\_item\_definition)  
 (product))

#### 5.1.14.15.6 document to plant\_item\_connector

#1: The whole document is associated with the plant\_item\_connector

#2: Part of the document is associated with the plant\_item\_connector

AIM element: PATH

Reference path: document  
 #1: (document <-  
 document\_usage\_constraint.source  
 document\_usage\_constraint <-  
 document\_usage\_constraint\_assignment.assigned\_document\_usage  
 document\_usage\_constraint\_assignment =>  
 applied\_document\_usage\_constraint\_assignment  
 applied\_document\_usage\_constraint\_assignment.items[i] ->  
 document\_usage\_constraint\_item =  
 plant\_item\_connector)  
 #2: (document <-  
 document\_reference.assigned\_document  
 document\_reference =>  
 applied\_document\_reference  
 applied\_document\_reference.items[i] ->  
 document\_item =  
 plant\_item\_connector)

#### 5.1.14.16 Ducting\_component

AIM element: product

Source: 41

Rules: dependent\_instantiable\_product\_context  
product\_context\_discipline\_type\_constraint  
value\_for\_application\_context

Reference path: {[product  
classification\_item = product  
classification\_item <-  
applied\_classification\_assignment.items[i]  
applied\_classification\_assignment <=  
classification\_assignment  
classification\_assignment.assigned\_classification ->  
group  
group.name = 'ducting component']  
[product  
product.frame\_of\_reference[i] ->  
product\_context<=  
application\_context\_element  
application\_context\_element.name = 'plant item']]}

#### 5.1.14.17 Electrical\_component

AIM element: product

Source: 41

Rules: dependent\_instantiable\_product\_context  
product\_context\_discipline\_type\_constraint  
value\_for\_application\_context

Reference path: {[product  
classification\_item = product  
classification\_item <-  
applied\_classification\_assignment.items[i]  
applied\_classification\_assignment <=  
classification\_assignment  
classification\_assignment.assigned\_classification ->  
group  
group.name = 'electrical component']  
[product  
product.frame\_of\_reference[i] ->  
product\_context<=  
application\_context\_element  
application\_context\_element.name = 'plant item']]}

#### 5.1.14.18 Equipment

AIM element: product

Source: 41

Rules: dependent\_instantiable\_product\_context  
product\_context\_discipline\_type\_constraint  
value\_for\_application\_context

Reference path: {[product  
classification\_item = product  
classification\_item <-  
applied\_classification\_assignment.items[i]  
applied\_classification\_assignment <=  
classification\_assignment  
classification\_assignment.assigned\_classification ->  
group  
group.name = 'equipment']  
[product  
product.frame\_of\_reference[i] ->  
product\_context<=  
application\_context\_element  
application\_context\_element.name = 'plant item']]}

### 5.1.14.18.1 equipment\_characteristics

AIM element: ([representation\_item.name]  
[(descriptive\_representation\_item.description)  
([measure\_with\_unit.value\_component]  
[measure\_with\_unit.unit\_component]))])  
  
([representation\_item.name]  
[(descriptive\_representation\_item.description)  
([measure\_with\_unit.value\_component]  
[measure\_with\_unit.unit\_component]))]  
[document\_usage\_constraint.subject\_element\_value])

Source: 41, 43, 45

Reference path: product <-  
product\_definition\_formation.of\_product  
product\_definition\_formation <-  
product\_definition.formation  
product\_definition  
characterized\_product\_definition = product\_definition  
characterized\_product\_definition  
characterized\_definition = characterized\_product\_definition  
characterized\_definition <-  
property\_definition.definition  
{property\_definition  
property\_definition.name = 'general characteristics'}  
property\_definition  
represented\_definition = property\_definition  
represented\_definition <-  
property\_definition\_representation.definition  
property\_definition\_representation  
property\_definition\_representation.used\_representation ->

```

representation
representation.items[i] ->
[representation_item
representation_item.name]
[representation_item =>
(descriptive_representation_item
descriptive_representation_item.description)
(measure_representation_item <=
measure_with_unit
[measure_with_unit.value_component]
[measure_with_unit.unit_component]))]
[(representation_item)
(representation_item
document_item = representation_item
document_item <-
applied_document_reference.items[i]
applied_document_reference <=
document_reference
document_reference.assigned_document ->
document <-
document_usage_constraint.source
document_usage_constraint
document_usage_constraint.subject_element_value)]

```

#### 5.1.14.18.2 equipment\_type

AIM element: group.name

Source: 41

Reference path: product  
classification\_item = product  
classification\_item <-  
applied\_classification\_assignment.items[i]  
applied\_classification\_assignment <=  
{classification\_assignment  
classification\_assignment.role ->  
classification\_role  
classification\_role.name = 'equipment type classification'}  
classification\_assignment  
classification\_assignment.assigned\_classification ->  
group  
group.name

#### 5.1.14.18.3 heat\_tracing\_type

AIM element: (heat\_tracing\_representation)  
([heat\_tracing\_representation]  
[document\_usage\_constraint.subject\_element\_value])

Source: 227

Reference path: product <-

```

product_definition_formation.of_product
product_definition_formation <-
product_definition.formation
product_definition
characterized_product_definition = product_definition
characterized_product_definition
characterized_definition = characterized_product_definition
characterized_definition <-
property_definition.definition
property_definition
represented_definition = property_definition
represented_definition <-
property_definition_representation.definition
property_definition_representation
property_definition_representation.used_representation ->
representation =>
(heat_tracing_representation)
([heat_tracing_representation]
[heat_tracing_representation
document_item = heat_tracing_representation
document_item <-
applied_document_reference.items[i]
applied_document_reference <=
document_reference
document_reference.assigned_document ->
document <-
document_usage_constraint.source
document_usage_constraint
document_usage_constraint.subject_element_value])
41

```

#### 5.1.14.18.4 insulation\_specification

AIM element: document\_usage\_constraint.subject\_element\_value

Source: 41

Reference path:

```

product
document_item = product
document_item <-
applied_document_reference.items[i]
applied_document_reference <=
document_reference
document_reference.assigned_document ->
document <-
document_usage_constraint.source
document_usage_constraint
document_usage_constraint.subject_element_value

```

#### 5.1.14.18.5 rated\_temperature

AIM element: [measure\_with\_unit.value\_component]

[measure\_with\_unit.unit\_component]

Source: 41

Reference path: product <-  
 product\_definition\_formation.of\_product  
 product\_definition\_formation <-  
 product\_definition.formation  
 product\_definition  
 characterized\_product\_definition = product\_definition  
 characterized\_product\_definition  
 characterized\_definition = characterized\_product\_definition  
 characterized\_definition <-  
 property\_definition.definition  
 property\_definition <-  
 represented\_definition = property\_definition  
 represented\_definition <-  
 property\_definition\_representation.definition  
 property\_definition\_representation  
 property\_definition\_representation.using\_representation ->  
 representation  
 {representation.name = 'equipment characteristics'}  
 (representation.items[i] ->  
 {representation\_item  
 (representation\_item.name = 'rated temperature')  
 (representation\_item.name = 'maximum rated temperature')  
 (representation\_item.name = 'minimum rated temperature'}})  
 ([representation.items[i] ->  
 {representation\_item  
 representation\_item.name = 'maximum rated temperature'}}]  
 [representation.items[i] ->  
 {representation\_item  
 representation\_item.name = 'minimum rated temperature'}}])  
 representation\_item =>  
 measure\_representation\_item <=  
 measure\_with\_unit  
 [measure\_with\_unit.value\_component]  
 [measure\_with\_unit.unit\_component]

#### 5.1.14.18.6 shock\_qualification\_status

AIM element: descriptive\_representation\_item.description

Source: 45

Reference path: product <-  
 product\_definition\_formation.of\_product  
 product\_definition\_formation <-  
 product\_definition.formation  
 product\_definition  
 characterized\_product\_definition = product\_definition  
 characterized\_product\_definition  
 characterized\_definition = characterized\_product\_definition  
 characterized\_definition <-

```

property_definition.definition
property_definition <-
property_definition_representation.definition
property_definition_representation
property_definition_representation.using_representation ->
representation
{representation.name = 'equipment characteristics'}
representation.items[i] ->
representation_item
{representation_item.name = 'shock qualification status'}
representation_item =>
descriptive_representation_item
descriptive_representation_item.description

```

#### 5.1.14.18.7 vibration\_amplitude

AIM element: [measure\_with\_unit.value\_component]  
[measure\_with\_unit.unit\_component]

Source: 41

Reference path:

```

product <-
product_definition_formation.of_product
product_definition_formation <-
product_definition.formation
product_definition
characterized_product_definition = product_definition
characterized_product_definition
characterized_definition = characterized_product_definition
characterized_definition <-
property_definition.definition
property_definition <-
represented_definition = property_definition
represented_definition <-
property_definition_representation.definition
property_definition_representation
property_definition_representation.using_representation ->
representation
{representation.name = 'equipment characteristics'}
(representation.items[i] ->
{representation_item
(representation_item.name = 'vibration amplitude')
(representation_item.name = 'maximum vibration amplitude')
(representation_item.name = 'minimum vibration amplitude'))})
([representation.items[i] ->
{representation_item
representation_item.name = 'maximum vibration amplitude'}}]
[representation.items[i] ->
{representation_item
representation_item.name = 'minimum vibration amplitude'}}])
representation_item =>
measure_representation_item <=
measure_with_unit

```

[measure\_with\_unit.value\_component]  
[measure\_with\_unit.unit\_component]

#### 5.1.14.18.8 vibration\_frequency

AIM element: [measure\_with\_unit.value\_component]  
[measure\_with\_unit.unit\_component]

Source: 41

Reference path: product <-  
product\_definition\_formation.of\_product  
product\_definition\_formation <-  
product\_definition.formation  
product\_definition  
characterized\_product\_definition = product\_definition  
characterized\_product\_definition  
characterized\_definition = characterized\_product\_definition  
characterized\_definition <-  
property\_definition.definition  
property\_definition <-  
represented\_definition = property\_definition  
represented\_definition <-  
property\_definition\_representation.definition  
property\_definition\_representation  
property\_definition\_representation.using\_representation ->  
representation  
{representation.name = 'equipment characteristics'}  
(representation.items[i] ->  
{representation\_item  
(representation\_item.name = 'vibration frequency')  
(representation\_item.name = 'maximum vibration frequency')  
(representation\_item.name = 'minimum vibration frequency'))}  
([representation.items[i] ->  
{representation\_item  
representation\_item.name = 'maximum vibration frequency'}]  
[representation.items[i] ->  
{representation\_item  
representation\_item.name = 'minimum vibration frequency'}}]  
representation\_item =>  
measure\_representation\_item <=  
measure\_with\_unit  
[measure\_with\_unit.value\_component]  
[measure\_with\_unit.unit\_component]

#### 5.1.14.18.9 equipment\_to\_equipment\_trim\_piping

AIM element: PATH

Reference path: product <-  
product\_definition\_formation.of\_product  
product\_definition\_formation <-  
product\_definition.formation

```

product_definition <-
product_definition_relationship.relatng_product_definition
product_definition_relationship
{product_definition_relationship
product_definition_relationship.name = 'trim piping'}

```

#### 5.1.14.18.10 equipment to supplied\_equipment

AIM element: IDENTICAL MAPPING

#### 5.1.14.19 Equipment\_breaching

AIM element: product

Source: 41

Rules: dependent\_instantiable\_product\_context  
product\_context\_discipline\_type\_constraint  
value\_for\_application\_context

Reference path: {[product  
classification\_item = product  
classification\_item <-  
applied\_classification\_assignment.items[i]  
applied\_classification\_assignment <=  
classification\_assignment  
classification\_assignment.assigned\_classification ->  
[group  
group.name = 'equipment breaching']  
[group <-  
group\_relationship.related\_group  
{group\_relationship  
group\_relationship.name = 'usage classification'}  
group\_relationship  
group\_relationship.relatng\_group ->  
group  
group.name = 'ducting component']]  
[product  
product.frame\_of\_reference[i] ->  
product\_context<=  
application\_context\_element  
application\_context\_element.name = 'plant item']]}

#### 5.1.14.20 Equipment\_trim\_piping

AIM element: product\_definition\_relationship

Source: 41

Reference path: {product\_definition\_relationship  
[product\_definition\_relationship.relatng\_product\_definition ->  
product\_definition  
product\_definition.formation ->

```

product_definition_formation
product_definition_formation.of_product ->
product
classification_item = product
classification_item <-
applied_classification_assignment.items[i]
applied_classification_assignment <=
classification_assignment
classification_assignment.assigned_classification ->
group
group.name = 'equipment']
[product_definition_relationship.related_product_definition ->
product_definition =>
piping_component_definition]
[product_definition_relationship.name = 'trim piping']]

```

#### 5.1.14.21 Externally\_defined\_document

AIM element: externally\_defined\_document

Source: 227

Reference path: externally\_defined\_document <=  
[document]  
[externally\_defined\_item]

##### 5.1.14.21.1 source\_id

AIM element: external\_source.source\_id

Source: 41

Reference path: externally\_defined\_document <=  
externally\_defined\_item  
externally\_defined\_item.source ->  
external\_source  
external\_source.source\_id

##### 5.1.14.21.2 source\_description

AIM element: description\_attribute.attribute\_value

Source: 41

Reference path: externally\_defined\_document <=  
externally\_defined\_item  
externally\_defined\_item.source ->  
external\_source  
description\_attribute\_select = external\_source  
description\_attribute\_select <-  
description\_attribute.described\_item  
description\_attribute

description\_attribute.attribute\_value

**5.1.14.22 Externally\_defined\_user\_defined\_attribute\_value**

AIM element: externally\_defined\_representation\_item

Source: 227

Reference path: externally\_defined\_representation <=  
[representation\_item]  
[externally\_defined\_item]**5.1.14.22.1 source**

AIM element: external\_source.name

Source: 41

Reference path: externally\_defined\_representation\_item <=  
externally\_defined\_item  
externally\_defined\_item.source ->  
external\_source  
external\_source.name**5.1.14.23 Functional\_design\_view**AIM element: (product\_definition)  
(externally\_defined\_plant\_item\_definition)

Source: 41, 227

Rules: dependent\_instantiable\_product\_context  
product\_context\_discipline\_type\_constraint  
value\_for\_application\_contextReference path: (product\_definition)  
(externally\_defined\_plant\_item\_definition <=  
[externally\_defined\_item]  
[product\_definition])  
{product\_definition  
[product\_definition.formation ->  
product\_definition\_formation  
product\_definition\_formation.of\_product ->  
product  
product.frame\_of\_reference[i] ->  
product\_context<=  
application\_context\_element  
application\_context\_element.name = 'plant item']  
[product\_definition.frame\_of\_reference ->  
[product\_definition\_context <=  
application\_context\_element  
(application\_context\_element.name = 'functional definition')  
(application\_context\_element.name = 'functional occurrence')]

```
[product_definition_context
product_definition_context.life_cycle_stage = 'functional design']}]}
```

#### 5.1.14.23.1 tag\_number

AIM element: product\_definition.id

Source: 41

Reference path: (product\_definition)  
 (externally\_defined\_plant\_item\_definition <=  
 product\_definition)  
 {product\_definition  
 product\_definition.frame\_of\_reference ->  
 product\_definition\_context <=  
 application\_context\_element  
 application\_context\_element.name = 'functional occurrence'}  
 product\_definition.id

#### 5.1.14.23.2 functional\_design\_view to functional\_plant\_item\_satisfaction

AIM element: PATH

Reference path: (product\_definition <-)  
 (externally\_defined\_plant\_item\_definition <=  
 product\_definition <-)  
 product\_definition\_relationship.relateing\_product\_definition  
 product\_definition\_relationship  
 {product\_definition\_relationship  
 product\_definition\_relationship.name = 'plant item satisfaction'}

#### 5.1.14.24 Functional\_plant\_item\_satisfaction

AIM element: product\_definition\_relationship

Source: 41

Reference path: {product\_definition\_relationship  
 product\_definition\_relationship.name = 'plant item satisfaction'}

#### 5.1.14.25 Hexagon\_head\_bolt

AIM element: bolt\_and\_nut\_component\_definition

Source: 227

Rules: dependent\_instantiable\_product\_context  
 product\_context\_discipline\_type\_constraint  
 value\_for\_application\_context

Reference path: bolt\_and\_nut\_component\_definition <=  
 product\_definition

```

{bolt_and_nut_component_definition
classification_item = piping_support_definition
classification_item <-
applied_classification_assignment.items[i]
applied_classification_assignment <=
classification_assignment
classification_assignment.assigned_classification ->
[group =>
bolt_and_nut_component_class]
[group
group.name = 'hexagon head bolt']
[group <-
group_relationship.related_group
group_relationship
{group_relationship.name = 'class hierarchy'}
group_relationship.relying_group ->
group
{[group.name = 'bolt']
[group =>
bolt_and_nut_component_class]}}
{product_definition
product_definition.formation ->
product_definition_formation
product_definition_formation.of_product ->
[product
classification_item = product
classification_item <-
applied_classification_assignment.items[i]
applied_classification_assignment <=
classification_assignment
classification_assignment.assigned_classification ->
(group)
(group <-
group_relationship.related_group
group_relationship
group_relationship.relying_group ->
group)
group.name = 'bolt and nut component']
[product
product.frame_of_reference[i] ->
product_context <=
application_context_element
application_context_element.name = 'plant item']})

```

#### 5.1.14.25.1 length

AIM element: [measure\_with\_unit.value\_component]  
[measure\_with\_unit.unit\_component]

Source: 41

Rules: subtype\_mandatory\_shape\_representation

Reference path: bolt\_and\_nut\_component\_definition <=  
product\_definition  
characterized\_product\_definition = product\_definition  
characterized\_product\_definition  
characterized\_definition = characterized\_product\_definition  
characterized\_definition <=  
property\_definition.definition  
property\_definition =>  
product\_definition\_shape <=  
shape\_aspect.of\_shape  
[shape\_aspect <=  
shape\_aspect\_relationship.relate\_shape\_aspect]  
[shape\_aspect <=  
shape\_aspect\_relationship.related\_shape\_aspect]  
shape\_aspect\_relationship =>  
dimensional\_location  
dimensional\_characteristic = dimensional\_location  
dimensional\_characteristic <=  
dimensional\_characteristic\_representation.dimension  
dimensional\_characteristic\_representation  
dimensional\_characteristic\_representation.representation ->  
shape\_dimension\_representation <=  
shape\_representation <=  
{representation  
representation.name = 'hexagon head bolt dimensional shape'}  
representation  
representation.items[i] ->  
representation\_item =>  
{representation\_item.name = 'length'}  
measure\_representation\_item <=  
{measure\_with\_unit =>  
length\_measure\_with\_unit}  
measure\_with\_unit  
[measure\_with\_unit.value\_component]  
[measure\_with\_unit.unit\_component]

#### 5.1.14.26 Hierarchically\_organized\_collection

AIM element: assembly\_component\_usage

Source: 44

Reference path: {assembly\_component\_usage <=  
product\_definition\_usage <=  
product\_definition\_relationship  
(product\_definition\_relationship.name = 'hierarchical collection')  
(product\_definition\_relationship.name = 'connected hierarchical collection')}

#### 5.1.14.27 Installed\_physical\_design\_view

AIM element: (product\_definition)  
(externally\_defined\_plant\_item\_definition)

Source: 41, 227

Rules: dependent\_instantiable\_product\_context  
product\_context\_discipline\_type\_constraint  
value\_for\_application\_context

Reference path: (product\_definition)  
(externally\_defined\_plant\_item\_definition <=  
[externally\_defined\_item]  
[product\_definition])  
{product\_definition  
[product\_definition.formation ->  
product\_definition\_formation  
product\_definition\_formation.of\_product ->  
product  
product.frame\_of\_reference[i] ->  
product\_context<=  
application\_context\_element  
application\_context\_element.name = 'plant item']  
[product\_definition.description = 'installed']  
[product\_definition.frame\_of\_reference ->  
[product\_definition\_context <=  
application\_context\_element  
application\_context\_element.name = 'physical occurrence']  
[product\_definition\_context  
product\_definition\_context.life\_cycle\_stage = 'physical design']]}

#### 5.1.14.27.1 serial\_number

AIM element: product\_definition.id

Source: 41

Reference path: (product\_definition)  
(externally\_defined\_plant\_item\_definition <=  
product\_definition)  
product\_definition.id

#### 5.1.14.28 Instrument

AIM element: product

Source: 41

Rules: dependent\_instantiable\_product\_context  
product\_context\_discipline\_type\_constraint  
value\_for\_application\_context

Reference path: {[product  
classification\_item = product  
classification\_item <=  
applied\_classification\_assignment.items[i]  
applied\_classification\_assignment <=

```

classification_assignment
classification_assignment.assigned_classification ->
[group
group.name = 'instrument']
[group <-
group_relationship.related_group
{group_relationship
group_relationship.name = 'usage classification'}
group_relationship
group_relationship.relying_group ->
group
group.name = 'instrumentation and control component']]
[product
product.frame_of_reference[i] ->
product_context<=
application_context_element
application_context_element.name = 'plant item']
[product <-
product_definition_formation.of_product
product_definition_formation <-
product_definition.formation
product_definition <-
product_definition_relationship.related_product_definition
{product_definition_relationship
product_definition_relationship.name = 'control loop element'}
product_definition_relationship
product_definition_relationship.relying_product_definition ->
product_definition
product_definition.formation ->
product_definition_formation
product_definition_formation.of_product ->
product
classification_item = product
classification_item <-
applied_classification_assignment.items[i]
applied_classification_assignment <=
classification_assignment
classification_assignment.assigned_classification ->
group
group.name = 'control loop']]

```

#### 5.1.14.28.1 control\_loop\_id

AIM element: product.id

Source: 41

Reference path: product <-  
product\_definition\_formation.of\_product  
product\_definition\_formation <-  
product\_definition.formation  
product\_definition <-  
product\_definition\_relationship.related\_product\_definition  
{product\_definition\_relationship

```

product_definition_relationship.name = 'control loop element'}
product_definition_relationship
product_definition_relationship.relying_product_definition ->
product_definition
product_definition.formation ->
product_definition_formation
product_definition_formation.of_product ->
product
product.id

```

#### 5.1.14.28.2 instrument\_type

AIM element: group.name

Source: 41

Reference path:

```

product
classification_item = product
classification_item <-
applied_classification_assignment.items[i]
applied_classification_assignment <=
{classification_assignment
classification_assignment.role ->
classification_role
classification_role.name = 'instrument type classification'}
classification_assignment
classification_assignment.assigned_classification ->
group
group.name

```

#### 5.1.14.28.3 sensor\_type

AIM element: descriptive\_representation\_item.description

Source: 45

Reference path:

```

product <-
product_definition_formation.of_product
product_definition_formation <-
product_definition.formation
product_definition
characterized_product_definition = product_definition
characterized_product_definition
characterized_definition = characterized_product_definition
characterized_definition <-
property_definition.definition
property_definition
represented_definition = property_definition
represented_definition <-
property_definition_representation.definition
property_definition_representation
property_definition_representation.used_representation ->
representation

```

```

representation.items[i] ->
{representation_item
representation_item.name = 'sensor type'}
representation_item =>
descriptive_representation_item
descriptive_representation_item.description

```

#### 5.1.14.28.4 **signal\_type**

AIM element: descriptive\_representation\_item.description

Source: 45

Reference path:

```

product <-
product_definition_formation.of_product
product_definition_formation <-
product_definition.formation
product_definition
characterized_product_definition = product_definition
characterized_product_definition
characterized_definition = characterized_product_definition
characterized_definition <-
property_definition.definition
property_definition
represented_definition = property_definition
represented_definition <-
property_definition_representation.definition
property_definition_representation
property_definition_representation.used_representation ->
representation
representation.items[i] ->
{representation_item
representation_item.name = 'signal type'}
representation_item =>
descriptive_representation_item
descriptive_representation_item.description

```

#### 5.1.14.28.5 **stream\_interaction\_type**

AIM element: descriptive\_representation\_item.description

Source: 45

Reference path:

```

product <-
product_definition_formation.of_product
product_definition_formation <-
product_definition.formation
product_definition
characterized_product_definition = product_definition
characterized_product_definition
characterized_definition = characterized_product_definition
characterized_definition <-
property_definition.definition

```

```

property_definition
represented_definition = property_definition
represented_definition <-
property_definition_representation.definition
property_definition_representation
property_definition_representation.used_representation ->
representation
representation.items[i] ->
{representation_item
representation_item.name = 'stream interaction type'}
representation_item =>
descriptive_representation_item
descriptive_representation_item.description

```

#### 5.1.14.29 Instrumentation\_and\_control\_component

AIM element: product

Source: 41

Rules: dependent\_instantiable\_product\_context  
product\_context\_discipline\_type\_constraint  
value\_for\_application\_context

Reference path: {[product  
classification\_item = product  
classification\_item <-  
applied\_classification\_assignment.items[i]  
applied\_classification\_assignment <=  
classification\_assignment  
classification\_assignment.assigned\_classification ->  
group  
group.name = 'instrumentation and control component']  
[product  
product.frame\_of\_reference[i] ->  
product\_context<=  
application\_context\_element  
application\_context\_element.name = 'plant item']]}

#### 5.1.14.30 Insulation

AIM element: product

Source: 41

Rules: dependent\_instantiable\_product\_context  
product\_context\_discipline\_type\_constraint  
value\_for\_application\_context

Reference path: {[product  
classification\_item = product  
classification\_item <-  
applied\_classification\_assignment.items[i]

```

applied_classification_assignment <=
classification_assignment
classification_assignment.assigned_classification ->
group
group.name = 'insulation']
[product
product.frame_of_reference[i] ->
product_context<=
application_context_element

```

### 5.1.14.31 Material\_specification\_selection

AIM element: [material\_property]  
[document]

Source: 41, 45

Reference path: { document  
document.kind ->  
document\_type  
document\_type.product\_data\_type = 'material specification'}

#### 5.1.14.31.1 description

AIM element: property\_definition.description

Source: 41

Reference path: material\_property <=  
property\_definition  
property\_definition.description

#### 5.1.14.31.2 material\_specification\_id

AIM element: document.id

Source: 41

#### 5.1.14.31.3 required\_or\_optional

AIM element: group.name

Source: 41

Reference path: document <-  
document\_reference.assigned\_document  
document\_reference =>  
applied\_document\_reference  
classification\_item = applied\_document\_reference  
classification\_item <-  
applied\_classification\_assignment.items[i]applied\_classification\_assignment <=  
classification\_assignment

```

classification_ssignment.assigned__classification>
group
{(group.name = 'required')
(group.name = 'optional')}

```

#### 5.1.14.31.4 selection\_id

AIM element: document\_usage\_constraint.subject\_element

Source: 41

Reference path: document <-  
document\_usage\_constraint.source  
document\_usage\_constraint  
document\_usage\_constraint.subject\_element

#### 5.1.14.31.5 type

AIM element: document\_usage\_constraint.subject\_element\_value

Source: 41

Reference path: document <-  
document\_usage\_constraint.source  
document\_usage\_constraint  
document\_usage\_constraint.subject\_element\_value

#### 5.1.14.31.6 material\_specification\_selection to material\_specification\_subset\_reference

AIM element: PATH

Reference path: document <-  
document\_relationship.relateing\_document  
document\_relationship  
{document\_relationship  
document\_relationship.description = 'subset'}

#### 5.1.14.32 Material\_specification\_subset\_reference

AIM element: document\_relationship

Source: 41

Reference path: {document\_relationship  
document\_relationship.description = 'subset'}

#### 5.1.14.32.1 subset\_id

AIM element: document\_relationship.name

Source: 41

### 5.1.14.33 Nozzle

AIM element: product

Source: 41

Rules: dependent\_instantiable\_product\_context  
product\_context\_discipline\_type\_constraint  
value\_for\_application\_context

Reference path: {[product  
classification\_item = product  
classification\_item <-  
applied\_classification\_assignment.items[i]  
applied\_classification\_assignment <=  
classification\_assignment  
classification\_assignment.assigned\_classification ->  
group  
group.name = 'nozzle']  
[product  
product.frame\_of\_reference[i] ->  
product\_context<=  
application\_context\_element  
application\_context\_element.name = 'plant item']]}

### 5.1.14.34 Nut

AIM element: bolt\_and\_nut\_component\_definition

Source: 227

Rules: dependent\_instantiable\_product\_context  
product\_context\_discipline\_type\_constraint  
value\_for\_application\_context

Reference path: bolt\_and\_nut\_component\_definition <=  
product\_definition  
{bolt\_and\_nut\_component\_definition  
classification\_item = piping\_support\_definition  
classification\_item <-  
applied\_classification\_assignment.items[i]  
applied\_classification\_assignment <=  
classification\_assignment  
classification\_assignment.assigned\_classification ->  
[group =>  
bolt\_and\_nut\_component\_class]  
[group  
group.name = 'nut']]  
{product\_definition  
product\_definition.formation ->  
product\_definition\_formation

```

product_definition_formation.of_product ->
[product
classification_item = product
classification_item <-
applied_classification_assignment.items[i]
applied_classification_assignment <=
classification_assignment
classification_assignment.assigned_classification ->
(group)
(group <-
group_relationship.related_group
group_relationship
group_relationship.relatng_group ->
group)
group.name = 'bolt and nut component']
[product
product.frame_of_reference[i] ->
product_context <=
application_context_element
application_context_element.name = 'plant item']]

```

#### 5.1.14.34.1 nut\_type

AIM element: group.name

Source: 41

Reference path:

```

bolt_and_nut_component_definition
classification_item = piping_support_definition
classification_item <-
applied_classification_assignment.items[i]
applied_classification_assignment <=
classification_assignment
classification_assignment.assigned_classification ->
group <-
{[group =>
bolt_and_nut_component_class]
[group
group.name = 'nut']}
group_relationship.relatng_group
group_relationship
{group_relationship.name = 'class hierarchy'}
group_relationship.related_group ->
group
{group =>
bolt_and_nut_component_class}
group.name

```

#### 5.1.14.35 Offline\_instrument

AIM element: product

Source: 41

Rules: dependent\_instantiable\_product\_context  
product\_context\_discipline\_type\_constraint  
value\_for\_application\_context

Reference path: {[product  
classification\_item = product  
classification\_item <-  
applied\_classification\_assignment.items[i]  
applied\_classification\_assignment <=  
classification\_assignment  
classification\_assignment.assigned\_classification ->  
[group  
group.name = 'offline instrument']  
[group <-  
group\_relationship.related\_group  
{group\_relationship  
group\_relationship.name = 'usage classification'}  
group\_relationship  
group\_relationship.relating\_group ->  
group  
group.name = 'instrument']]  
[product  
product.frame\_of\_reference[i] ->  
product\_context<=  
application\_context\_element  
application\_context\_element.name = 'plant item']]}

### 5.1.14.36 Physical\_design\_view

AIM element: (product\_definition)  
(externally\_defined\_plant\_item\_definition)

Source: 41, 227

Rules: dependent\_instantiable\_product\_context  
product\_context\_discipline\_type\_constraint  
value\_for\_application\_context

Reference path: (product\_definition)  
(externally\_defined\_plant\_item\_definition <=  
[externally\_defined\_item]  
[product\_definition])  
{product\_definition  
[product\_definition.formation ->  
product\_definition\_formation  
product\_definition\_formation.of\_product ->  
product  
product.frame\_of\_reference[i] ->  
product\_context<=  
application\_context\_element  
application\_context\_element.name = 'plant item']  
[product\_definition.frame\_of\_reference ->

```
[product_definition_context <=
application_context_element
(application_context_element.name = 'physical definition')
(application_context_element.name = 'physical occurrence')]
[product_definition_context
product_definition_context.life_cycle_stage = 'physical design']]}
```

#### **5.1.14.36.1 physical\_design\_view to functional\_plant\_item\_satisfaction**

AIM element: PATH

Reference path: (product\_definition <-)  
 (externally\_defined\_plant\_item\_definition <=  
 product\_definition <-)  
 product\_definition\_relationship.related\_product\_definition  
 product\_definition\_relationship  
 {product\_definition\_relationship  
 product\_definition\_relationship.name = 'plant item satisfaction'}

#### **5.1.14.36.2 physical\_design\_view to installed\_physical\_design\_view**

#### **5.1.14.37 Piping\_assembly**

AIM element: product\_definition

Source: 41

Reference path: {product\_definition  
 product\_definition.frame\_of\_reference ->  
 product\_definition\_context <=  
 application\_context\_element  
 application\_context\_element.name = 'fabrication assembly'}

#### **5.1.14.37.1 piping\_assembly\_number**

AIM element: product\_definition.id

Source: 41

#### **5.1.14.37.2 piping\_assembly to piping\_assembly\_assignment**

AIM element: PATH

Reference path: product\_definition <-  
 product\_definition\_relationship.relateing\_product\_definition  
 product\_definition\_relationship =>  
 product\_definition\_usage

#### **5.1.14.38 Piping\_assembly\_assignment**

AIM element: product\_definition\_usage

Source: 44

Reference path: {product\_definition\_usage <=  
product\_definition\_relationship  
[product\_definition\_relationship.relateing\_product\_definition ->  
product\_definition  
product\_definition.frame\_of\_reference ->  
product\_definition\_context <=  
application\_context\_element  
application\_context\_element.name = 'fabrication assembly']  
[product\_definition\_relationship.related\_product\_definition ->  
{(product\_definition)  
(product\_definition =>  
externally\_defined\_plant\_item\_definition}  
product\_definition  
product\_definition.frame\_of\_reference ->  
product\_definition\_context <=  
application\_context\_element  
(application\_context\_element.name = 'functional occurrence')  
(application\_context\_element.name = 'physical occurrence')}]}

### 5.1.14.39 Piping\_system\_component

AIM element: piping\_component\_definition

Source: 227

Rules: dependent\_instantiable\_product\_context  
product\_context\_discipline\_type\_constraint  
value\_for\_application\_context

Reference path: piping\_component\_definition <=  
product\_definition  
{product\_definition  
product\_definition.formation ->  
product\_definition\_formation  
product\_definition\_formation.of\_product ->  
product  
product.frame\_of\_reference[i] ->  
product\_context<=  
application\_context\_element  
application\_context\_element.name = 'plant item'}

#### 5.1.14.39.1 coating\_reference

AIM element: descriptive\_representation\_item.description

Source: 45

Reference path: piping\_component\_definition <=  
product\_definition

```

characterized_product_definition = product_definition
characterized_product_definition
characterized_definition = characterized_product_definition
characterized_definition <-
property_definition.definition
property_definition
represented_definition = property_definition
represented_definition <-
property_definition_representation.definition
property_definition_representation
property_definition_representation.used_representation ->
{representation
representation.name = 'system coating and lining'}
representation
representation.items[i] ->
{representation_item
representation_item.name = 'coating'}
representation_item =>
descriptive_representation_item
descriptive_representation_item.description

```

### 5.1.14.39.2 corrosion\_allowance

AIM element: [measure\_with\_unit.value\_component]  
[measure\_with\_unit.unit\_component]

Source: 41

Reference path:

```

piping_component_definition <=
product_definition
characterized_product_definition = product_definition
characterized_product_definition
characterized_definition = characterized_product_definition
characterized_definition <-
property_definition.definition
property_definition
represented_definition = property_definition
represented_definition <-
property_definition_representation.definition
property_definition_representation
property_definition_representation.used_representation ->
{representation
representation.name = 'system coating and lining'}
representation
(representation.items[i] ->
{representation_item
(representation_item.name = 'corrosion allowance')
(representation_item.name = 'maximum corrosion allowance')
(representation_item.name = 'minimum corrosion allowance'))}
([representation.items[i] ->
{representation_item
representation_item.name = 'maximum corrosion allowance'}}]
[representation.items[i] ->
{representation_item

```

```

representation_item.name = 'minimum corrosion allowance'}})
representation_item =>
measure_representation_item <=
measure_with_unit
[measure_with_unit.value_component]
[measure_with_unit.unit_component]

```

### 5.1.14.39.3 heat\_tracing\_type

AIM element: (heat\_tracing\_representation)  
([heat\_tracing\_representation]  
[document\_usage\_constraint.subject\_element\_value])

Source: 227

Reference path: piping\_component\_definition <=  
product\_definition  
characterized\_product\_definition = product\_definition  
characterized\_product\_definition  
characterized\_definition = characterized\_product\_definition  
characterized\_definition <=  
property\_definition.definition  
property\_definition  
represented\_definition = property\_definition  
represented\_definition <=  
property\_definition\_representation.definition  
property\_definition\_representation  
property\_definition\_representation.used\_representation ->  
representation =>  
(heat\_tracing\_representation)  
([heat\_tracing\_representation]  
[heat\_tracing\_representation  
document\_item = heat\_tracing\_representation  
document\_item <=  
applied\_document\_reference.items[i]  
applied\_document\_reference <=  
document\_reference  
document\_reference.assigned\_document ->  
document <=  
document\_usage\_constraint.source  
document\_usage\_constraint  
document\_usage\_constraint.subject\_element\_value])  
41

### 5.1.14.39.4 lining

AIM element: descriptive\_representation\_item.description

Source: 45

Reference path: piping\_component\_definition <=  
product\_definition  
characterized\_product\_definition = product\_definition

```

characterized_product_definition
characterized_definition = characterized_product_definition
characterized_definition <-
property_definition.definition
property_definition
represented_definition = property_definition
represented_definition <-
property_definition_representation.definition
property_definition_representation
property_definition_representation.used_representation ->
{representation
representation.name = 'system coating and lining'}
representation
representation.items[i] ->
{representation_item
representation_item.name = 'lining'}
representation_item =>
descriptive_representation_item
descriptive_representation_item.description

```

#### **5.1.14.39.5 piping\_system\_component to equipment\_trim\_piping**

AIM element: PATH

Reference path: piping\_component\_definition <=  
product\_definition <-  
product\_definition\_relationship.related\_product\_definition  
{product\_definition\_relationship  
product\_definition\_relationship.name = 'trim piping'}  
product\_definition\_relationship

#### **5.1.14.39.6 piping\_system\_component to line\_piping\_system\_component - assignment**

AIM element: PATH

Reference path: piping\_component\_definition <=  
product\_definition <-  
product\_definition\_relationship.related\_product\_definition  
{product\_definition\_relationship  
product\_definition\_relationship.name = 'realization'}  
product\_definition\_relationship

#### **5.1.14.39.7 piping\_system\_component to piping\_size\_description**

AIM element: PATH

Rules: subtype\_mandatory\_shape\_representation

Reference path: piping\_component\_definition <=  
product\_definition  
characterized\_product\_definition = product\_definition

```

characterized_product_definition
characterized_definition = characterized_product_definition
characterized_definition <-
property_definition.definition
{property_definition =>
product_definition_shape}
property_definition
represented_definition = property_definition
represented_definition <-
property_definition_representation.definition
{property_definition_representation =>
shape_definition_representation}
property_definition_representation
property_definition_representation.used_representation ->
representation =>
shape_representation =>
shape_dimension_representation

```

#### 5.1.14.40 Plain\_washer

AIM element: bolt\_and\_nut\_component\_definition

Source: 227

Rules: dependent\_instantiable\_product\_context  
product\_context\_discipline\_type\_constraint  
value\_for\_application\_context

Reference path: bolt\_and\_nut\_component\_definition <=  
product\_definition  
{bolt\_and\_nut\_component\_definition  
classification\_item = piping\_support\_definition  
classification\_item <-  
applied\_classification\_assignment.items[i]  
applied\_classification\_assignment <=  
classification\_assignment  
classification\_assignment.assigned\_classification ->  
[group =>  
bolt\_and\_nut\_component\_class]  
[group  
group.name = 'plain washer']  
[group <-  
group\_relationship.related\_group  
group\_relationship  
{group\_relationship.name = 'class hierarchy'}  
group\_relationship.relying\_group ->  
group  
{[group.name = 'washer']  
[group =>  
bolt\_and\_nut\_component\_class]}}  
{product\_definition  
product\_definition.formation ->  
product\_definition\_formation  
product\_definition\_formation.of\_product ->

```

[product
classification_item = product
classification_item <-
applied_classification_assignment.items[i]
applied_classification_assignment <=
classification_assignment
classification_assignment.assigned_classification ->
(group)
(group <-
group_relationship.related_group
group_relationship
group_relationship.relying_group ->
group)
group.name = 'bolt and nut component']
[product
product.frame_of_reference[i] ->
product_context <=
application_context_element
application_context_element.name = 'plant item']]

```

#### 5.1.14.40.1 thickness

AIM element: [measure\_with\_unit.value\_component]  
[measure\_with\_unit.unit\_component]

Source: 41

Rules: subtype\_mandatory\_shape\_representation

Reference path: bolt\_and\_nut\_component\_definition <=  
product\_definition  
characterized\_product\_definition = product\_definition  
characterized\_product\_definition  
characterized\_definition = characterized\_product\_definition  
characterized\_definition <=  
property\_definition.definition  
property\_definition =>  
product\_definition\_shape <=  
shape\_aspect.of\_shape  
[shape\_aspect <=  
shape\_aspect\_relationship.relying\_shape\_aspect]  
[shape\_aspect <=  
shape\_aspect\_relationship.related\_shape\_aspect]  
shape\_aspect\_relationship =>  
dimensional\_location  
dimensional\_characteristic = dimensional\_location  
dimensional\_characteristic <=  
dimensional\_characteristic\_representation.dimension  
dimensional\_characteristic\_representation  
dimensional\_characteristic\_representation.representation ->  
shape\_dimension\_representation <=  
shape\_representation <=  
{representation  
representation.name = 'plain washer dimensional shape'}

```

representation
representation.items[i] ->
representation_item =>
{representation_item.name = 'thickness'}
measure_representation_item <=
{measure_with_unit =>
length_measure_with_unit}
measure_with_unit
[measure_with_unit.value_component]
[measure_with_unit.unit_component]

```

#### 5.1.14.40.2 outside\_diameter

AIM element: [measure\_with\_unit.value\_component]  
[measure\_with\_unit.unit\_component]

Source: 41

Rules: subtype\_mandatory\_shape\_representation

Reference path: bolt\_and\_nut\_component\_definition <=

```

product_definition
characterized_product_definition = product_definition
characterized_product_definition
characterized_definition = characterized_product_definition
characterized_definition <-
property_definition.definition
property_definition =>
product_definition_shape <-
shape_aspect.of_shape
[shape_aspect <-
shape_aspect_relationship.relate_shape_aspect]
[shape_aspect <-
shape_aspect_relationship.related_shape_aspect]
shape_aspect_relationship =>
dimensional_location
dimensional_characteristic = dimensional_location
dimensional_characteristic <-
dimensional_characteristic_representation.dimensional
dimensional_characteristic_representation
dimensional_characteristic_representation.representation ->
shape_dimension_representation <=
shape_representation <=
{representation
representation.name = 'plain washer dimensional shape'}
representation
representation.items[i] ->
representation_item =>
{representation_item.name = 'outside diameter'}
measure_representation_item <=
{measure_with_unit =>
length_measure_with_unit}
measure_with_unit

```

[measure\_with\_unit.value\_component]  
 [measure\_with\_unit.unit\_component]

#### 5.1.14.41 Planned\_physical\_plant\_item

AIM element: (product\_definition)  
 (externally\_defined\_plant\_item\_definition)

Source: 41, 227

Rules: dependent\_instantiable\_product\_context  
 product\_context\_discipline\_type\_constraint  
 value\_for\_application\_context

Reference path: (product\_definition)  
 (externally\_defined\_plant\_item\_definition <=  
 [product\_definition]  
 [externally\_defined\_item])  
 {product\_definition  
 [product\_definition.formation ->  
 product\_definition\_formation  
 product\_definition\_formation.of\_product ->  
 product  
 product.frame\_of\_reference[i] ->  
 product\_context<=  
 application\_context\_element  
 application\_context\_element.name = 'plant item']  
 [product\_definition.frame\_of\_reference ->  
 product\_definition\_context <=  
 application\_context\_element  
 (application\_context\_element.name = 'functional occurrence')  
 (application\_context\_element.name = 'physical occurrence')}]}

##### 5.1.14.41.1 stock\_code

AIM element: identification\_assignment.assigned\_id

Source: 41

Reference path: (product\_definition)  
 (externally\_defined\_plant\_item\_definition <=  
 [product\_definition]  
 [externally\_defined\_item])  
 product\_definition  
 identified\_item = product\_definition  
 identification\_assignment.items[i] ->  
 {identification\_assignment  
 identification\_assignment.role ->  
 identification\_role  
 identification\_role.name = 'stock code'}  
 identification\_assignment  
 identification\_assignment.assigned\_id

**5.1.14.41.2 global\_unambiguous\_identifier**

AIM element: identification\_assignment.assigned\_id

Source: 41

Reference path: (product\_definition)  
 (externally\_defined\_plant\_item\_definition <=  
 [product\_definition]  
 [externally\_defined\_item])  
 product\_definition  
 identified\_item = product\_definition  
 identification\_assignment.items[i] ->  
 {identification\_assignment  
 identification\_assignment.role ->  
 identification\_role  
 identification\_role.name = 'global unambiguous identifier'}  
 identification\_assignment  
 identification\_assignment.assigned\_id

**5.1.14.41.3 planned\_physical\_plant\_item to plant\_item\_connector - occurrence**

AIM element: PATH

Reference path: (product\_definition)  
 (externally\_defined\_plant\_item\_definition <=  
 product\_definition)  
 characterized\_product\_definition = product\_definition  
 characterized\_product\_definition  
 characterized\_definition = characterized\_product\_definition  
 characterized\_definition <-  
 property\_definition.definition  
 property\_definition =>  
 product\_definition\_shape <-  
 shape\_aspect.of\_shape  
 shape\_aspect =>  
 plant\_item\_connector

**5.1.14.41.4 planned\_physical\_plant\_item to piping\_spool\_assignment**

AIM element: PATH

Reference path: (product\_definition <-)  
 (externally\_defined\_plant\_item\_definition <=  
 product\_definition <-)  
 product\_definition\_relationship.related\_product\_definition  
 product\_definition\_relationship =>  
 product\_definition\_usage

**5.1.14.41.5 planned\_physical\_plant\_item to support\_usage (supported by)**

AIM element: PATH

Reference path: (product\_definition <-)  
 (externally\_defined\_plant\_item\_definition <=  
 product\_definition <-)  
 product\_definition\_relationship.related\_product\_definition  
 {product\_definition\_relationship  
 (product\_definition\_relationship.name = 'support usage')  
 (product\_definition\_relationship.name = 'support usage connection')}  
 product\_definition\_relationship

#### 5.1.14.41.6 planned\_physical\_plant\_item to support\_usage (supports)

AIM element: PATH

Reference path: (product\_definition <-)  
 (externally\_defined\_plant\_item\_definition <=  
 product\_definition <-)  
 product\_definition\_relationship.relateing\_product\_definition  
 {product\_definition\_relationship  
 (product\_definition\_relationship.name = 'support usage')  
 (product\_definition\_relationship.name = 'support usage connection')}  
 product\_definition\_relationship

#### 5.1.14.42 Plant\_item

AIM element: (product\_definition)  
 (externally\_defined\_plant\_item\_definition)  
 (product)

Source: 41, 227

Rules: dependent\_instantiable\_product\_context  
 product\_context\_discipline\_type\_constraint  
 value\_for\_application\_context

Reference path: (product\_definition)  
 (externally\_defined\_plant\_item\_definition <=  
 [product\_definition]  
 [externally\_defined\_item])  
 (product)  
 {(product\_definition  
 product\_definition.formation ->  
 product\_definition\_formation  
 product\_definition\_formation.of\_product ->  
 product)  
 (product)  
 product.frame\_of\_reference[i] ->  
 [product\_context  
 product\_context.discipline\_type = 'process plant']  
 [product\_context <=  
 application\_context\_element  
 application\_context\_element.name = 'plant item']]}

```
{(product <-
product_definition_formation.of_product
product_definition_formation <-
product_definition.formation
product_definition)
(product_definition)
product_definition.frame_of_reference ->
product_definition_context
(product_definition_context.life_cycle_stage = 'physical design')
(product_definition_context.life_cycle_stage = 'functional design')}
```

#### 5.1.14.42.1 description

AIM element: product.description

Source: 41

Reference path: (product\_definition)  
 (externally\_defined\_plant\_item\_definition <=  
 product\_definition)  
 product\_definition.formation ->  
 product\_definition\_formation  
 product\_definition\_formation.of\_product ->  
 product  
 product.description

#### 5.1.14.42.2 name

AIM element: product.name

Source: 41

Reference path: (product\_definition)  
 (externally\_defined\_plant\_item\_definition <=  
 product\_definition)  
 product\_definition.formation ->  
 product\_definition\_formation  
 product\_definition\_formation.of\_product ->  
 product  
 product.name

#### 5.1.14.42.3 plant\_item\_id

AIM element: product.id

Source: 41

Reference path: (product\_definition)  
 (externally\_defined\_plant\_item\_definition <=  
 product\_definition)  
 product\_definition.formation ->  
 product\_definition\_formation  
 product\_definition\_formation.of\_product ->

product  
product.id

#### 5.1.14.42.4 status

AIM element: group.name

Source: 41

Reference path: (product\_definition)  
(externally\_defined\_plant\_item\_definition <=  
product\_definition)  
classification\_item = product\_definition  
classification\_item <=  
applied\_classification\_assignment.items[i]  
applied\_classification\_assignment <=  
{classification\_assignment  
classification\_assignment.role ->  
group\_role  
group\_role.name = 'plant item status'}  
classification\_assignment  
classification\_assignment.assigned\_classification ->  
group  
group.name

#### 5.1.14.42.5 type

AIM element: group.name

Source: 41

Reference path: (product\_definition)  
(externally\_defined\_plant\_item\_definition <=  
product\_definition)  
product\_definition.formation ->  
product\_definition\_formation  
product\_definition\_formation.of\_product ->  
product classification\_item = product  
classification\_item <=  
applied\_classification\_assignment.items[i]  
applied\_classification\_assignment <=  
{classification\_assignment  
classification\_assignment.role ->  
classification\_role  
classification\_role.name = 'plant item type classification'}  
classification\_assignment  
classification\_assignment.assigned\_classification ->  
group  
group.name

#### 5.1.14.42.6 plant\_item to changed\_plant\_item

AIM element: IDENTICAL MAPPING

#### 5.1.14.42.7 plant\_item to external\_classification

AIM element: PATH

Reference path: (product\_definition)  
 (externally\_defined\_plant\_item\_definition <=  
 product\_definition)  
 classification\_item = product\_definition  
 classification\_item <=  
 applied\_classification\_assignment.items[i]  
 applied\_classification\_assignment <=  
 classification\_assignment  
 classification\_assignment.assigned\_classification ->  
 group =>  
 externally\_defined\_class

#### 5.1.14.42.8 plant\_item to insulation

AIM element: PATH

Reference path: (product\_definition <-)  
 (externally\_defined\_plant\_item\_definition <=  
 product\_definition <-)  
 (product <-  
 product\_definition\_formation.of\_product  
 product\_definition\_formation <-  
 product\_definition.formation  
 product\_definition <-)  
 product\_definition\_relationship.relate\_product\_definition  
 {product\_definition\_relationship  
 product\_definition\_relationship.name = 'item insulation'}  
 product\_definition\_relationship  
 product\_definition\_relationship.related\_product\_definition ->  
 product\_definition  
 product\_definition.formation ->  
 product\_definition\_formation  
 product\_definition\_formation.of\_product ->  
 product  
 {product  
 classification\_item = product  
 classification\_item <=  
 applied\_classification\_assignment.items[i]  
 applied\_classification\_assignment <=  
 classification\_assignment  
 classification\_assignment.assigned\_classification ->  
 group  
 group.name = 'insulation'}

#### 5.1.14.42.9 plant\_item to plant\_item\_collection (element)

AIM element: PATH

Reference path: (product\_definition <-)  
 (externally\_defined\_plant\_item\_definition <=  
 product\_definition <-)  
 (product <-  
 product\_definition\_formation.of\_product  
 product\_definition\_formation <-  
 product\_definition.formation  
 product\_definition <-)  
 product\_definition\_relationship.related\_product\_definition  
 product\_definition\_relationship

#### 5.1.14.42.10 plant\_item to plant\_item\_collection (group)

AIM element: PATH

Reference path: (product\_definition <-)  
 (externally\_defined\_plant\_item\_definition <=  
 product\_definition <-)  
 (product <-  
 product\_definition\_formation.of\_product  
 product\_definition\_formation <-  
 product\_definition.formation  
 product\_definition <-)  
 product\_definition\_relationship.relatng\_product\_definition  
 product\_definition\_relationship

#### 5.1.14.42.11 plant\_item to plant\_item\_design\_view

AIM element: (IDENTICAL MAPPING)  
 (PATH)

Source:

Reference path: product <-  
 product\_definition\_formation.of\_product  
 product\_definition\_formation <-  
 product\_definition.formation  
 (product\_definition)  
 (product\_definition =>  
 externally\_defined\_plant\_item\_definition)

#### 5.1.14.42.12 plant\_item to plant\_item\_shape

AIM element: PATH

Reference path: (product\_definition)  
 (externally\_defined\_plant\_item\_definition <=  
 product\_definition)  
 (product <-  
 product\_definition\_formation.of\_product  
 product\_definition\_formation <-

```

product_definition.formation
product_definition)
characterized_product_definition = product_definition
characterized_product_definition
characterized_definition = characterized_product_definition
characterized_definition <-
property_definition.definition
property_definition =>
product_definition_shape

```

#### 5.1.14.42.13 plant\_item to plant\_item\_weight

AIM element: PATH

Reference path:

```

(product_definition)
(externally_defined_plant_item_definition <=
product_definition)
(product <-
product_definition_formation.of_product
product_definition_formation <-
product_definition.formation
product_definition)
characterized_product_definition = product_definition
characterized_product_definition
characterized_definition = characterized_product_definition
characterized_definition <-
property_definition.definition
property_definition
represented_definition = property_definition
represented_definition <-
property_definition_representation.definition
property_definition_representation =>
plant_item_weight_representation

```

#### 5.1.14.42.14 plant\_item to reference\_geometry

AIM element: PATH

Reference path:

```

(product_definition)
(externally_defined_plant_item_definition <=
product_definition)
(product <-
product_definition_formation.of_product
product_definition_formation <-
product_definition.formation
product_definition)
characterized_product_definition = product_definition
characterized_product_definition
characterized_definition = characterized_product_definition
characterized_definition <-
property_definition.definition
property_definition =>
product_definition_shape <-

```

```

shape_aspect.of_shape
shape_aspect =>
derived_shape_aspect =>
reference_geometry

```

#### 5.1.14.42.15 plant\_item to required\_material\_description

#1: The quantity is not known or not yet specified.

#2: The quantity is known.

AIM element: PATH

Reference path: (product\_definition <-)  
 (externally\_defined\_plant\_item\_definition <=  
 product\_definition <-)  
 (product <-  
 product\_definition\_formation.of\_product  
 product\_definition\_formation <-  
 product\_definition.formation  
 product\_definition <-)  
 product\_definition\_relationship.relating\_product\_definition  
 {product\_definition\_relationship =>  
 #1: (product\_definition\_usage)  
 #2: (product\_definition\_usage =>  
 make\_from\_usage\_option)}  
 product\_definition\_relationship  
 product\_definition\_relationship.related\_product\_definition ->  
 product\_definition

#### 5.1.14.42.16 plant\_item to spare\_plant\_item\_usage (as primary)

AIM element: PATH

Reference path: (product\_definition <-)  
 (externally\_defined\_plant\_item\_definition <=  
 product\_definition <-)  
 (product <-  
 product\_definition\_formation.of\_product  
 product\_definition\_formation <-  
 product\_definition.formation  
 product\_definition <-)  
 product\_definition\_relationship.related\_product\_definition  
 product\_definition\_relationship  
 {product\_definition\_relationship  
 product\_definition\_relationship.name = 'spare plant item usage'}

#### 5.1.14.42.17 plant\_item to spare\_plant\_item\_usage (as spare)

AIM element: PATH

Reference path: (product\_definition <-)  
 (externally\_defined\_plant\_item\_definition <=

```

product_definition <-)
(product <-
product_definition_formation.of_product
product_definition_formation <-
product_definition.formation
product_definition <-)
product_definition_relationship.related_product_definition
product_definition_relationship
{product_definition_relationship
product_definition_relationship.name = 'spare plant item usage'}

```

#### 5.1.14.42.18 plant\_item to analysis\_data\_point

AIM element: PATH

Reference path:

```

(product_definition)
(externally_defined_plant_item_definition <=
product_definition)
(product <-
product_definition_formation.of_product
product_definition_formation <-
product_definition.formation
product_definition)
characterized_product_definition = product_definition
characterized_product_definition
characterized_definition = characterized_product_definition
characterized_definition <-
property_definition.definition
property_definition =>
product_definition_shape <-
shape_aspect.of_shape
shape_aspect
{shape_aspect.description = 'analysis data point'}

```

#### 5.1.14.43 Plant\_item\_collection

AIM element: product\_definition\_relationship

Source: 41

Reference path:

```

{product_definition_relationship
[product_definition_relationship.relateing_product_definition ->]
[product_definition_relationship.related_product_definition ->]
(product_definition)
(product_definition =>
externally_defined_plant_item_definition)}

```

##### 5.1.14.43.1 location\_and\_orientation

AIM element: (axis2\_placement\_2d)  
(axis2\_placement\_3d)

Source: 42

Reference path: product\_definition\_relationship  
characterized\_product\_definition = product\_definition\_relationship  
characterized\_product\_definition  
characterized\_definition = characterized\_product\_definition  
characterized\_definition <-  
property\_definition.definition  
property\_definition  
represented\_definition = property\_definition  
represented\_definition <-  
property\_definition\_representation.definition  
property\_definition\_representation  
property\_definition\_representation.used\_representation ->  
representation  
representation.items[i] ->  
representation\_item =>  
geometric\_representation\_item =>  
placement =>  
(axis2\_placement\_2d)  
(axis2\_placement\_3d)

#### 5.1.14.43.2 usage\_type

AIM element: product\_definition\_relationship.name

Source: 41

#### 5.1.14.43.3 plant\_item\_collection to changed\_plant\_item\_collection

AIM element: IDENTICAL MAPPING

#### 5.1.14.44 Plant\_item\_definition

AIM element: (product\_definition)  
(externally\_defined\_plant\_item\_definition)

Source: 41, 227

Rules: dependent\_instantiable\_product\_context  
product\_context\_discipline\_type\_constraint  
value\_for\_application\_context

Reference path: (product\_definition)  
(externally\_defined\_plant\_item\_definition <=  
[product\_definition]  
[externally\_defined\_item])  
{product\_definition  
[product\_definition.formation ->  
product\_definition\_formation  
product\_definition\_formation.of\_product ->  
product  
product.frame\_of\_reference[i] ->

```

product_context<=
application_context_element
application_context_element.name = 'plant item']
[product_definition.frame_of_reference ->
product_definition_context <=
application_context_element
(application_context_element.name = 'functional definition')
(application_context_element.name = 'physical definition')]]

```

#### 5.1.14.44.1 plant\_item\_definition to catalogue\_item (is defined as)

#1: Instances of the definition use the same catalogue item.

#2: Instances of the definition use different catalogue items.

AIM element: PATH

Reference path:

```

(product_definition <-)
(externally_defined_plant_item_definition <=
product_definition <-)
#1: (product_definition_relationship.related_product_definition
{product_definition_relationship
product_definition_relationship.name = 'catalogue usage'}
product_definition_relationship
product_definition_relationship.relateing_product_definition ->)
#2: (product_definition_relationship.relateing_product_definition
{product_definition_relationship
product_definition_relationship.name = 'definition usage'}
product_definition_relationship
product_definition_relationship.related_product_definition ->
{product_definition
product_definition.frame_of_reference ->
product_definition_context <=
application_context_element
(application_context_element.name = 'physical occurrence')
(application_context_element.name = 'functional occurrence')})
(product_definition <-)
({product_definition =>
externally_defined_plant_item_definition}
product_definition <-)
product_definition_relationship.related_product_definition
{product_definition_relationship
product_definition_relationship.name = 'catalogue usage'}
product_definition_relationship
product_definition_relationship.relateing_product_definition ->)
product_definition =>
externally_defined_plant_item_definition =>
catalogue_item

```

#### 5.1.14.44.2 plant\_item\_definition to connector\_definition

AIM element: PATH

Reference path: (product\_definition)  
 (externally\_defined\_plant\_item\_definition <=  
 product\_definition)  
 characterized\_product\_definition = product\_definition  
 characterized\_product\_definition  
 characterized\_definition = characterized\_product\_definition  
 characterized\_definition <=  
 property\_definition.definition  
 property\_definition =>  
 product\_definition\_shape <=  
 shape\_aspect.of\_shape  
 shape\_aspect =>  
 plant\_item\_connector

### 5.1.14.44.3 plant\_item\_definition to planned\_physical\_plant\_item

#1: The definition is physical.

#2: The definition is functional.

AIM element: PATH

Rules:  
 application\_context\_requires\_ap\_definition  
 dependent\_instantiable\_application\_context  
 dependent\_instantiable\_product\_definition\_context  
 product\_definition\_context\_name\_constraint  
 product\_definition\_usage\_constraint

Reference path: #1: ((product\_definition <-)  
 (externally\_defined\_plant\_item\_definition <=  
 product\_definition <-)  
 {product\_definition  
 product\_definition.frame\_of\_reference ->  
 product\_definition\_context <=  
 application\_context\_element  
 application\_context\_element.name = 'physical definition'}  
 product\_definition\_relationship.relying\_product\_definition  
 {product\_definition\_relationship  
 product\_definition\_relationship.name = 'definition usage'}  
 product\_definition\_relationship  
 product\_definition\_relationship.related\_product\_definition ->  
 {product\_definition  
 product\_definition.frame\_of\_reference ->  
 product\_definition\_context <=  
 application\_context\_element  
 application\_context\_element.name = 'physical occurrence'}  
 (product\_definition)  
 (product\_definition =>  
 externally\_defined\_plant\_item\_definition))  
 #2: ((product\_definition <-)  
 (externally\_defined\_plant\_item\_definition <=  
 product\_definition <-)  
 {product\_definition  
 product\_definition.frame\_of\_reference ->

```

product_definition_context <=
application_context_element
application_context_element.name = 'functional definition'}
product_definition_relationship.relatng_product_definition
{product_definition_relationship
product_definition_relationship.name = 'definition usage'}
product_definition_relationship
product_definition_relationship.related_product_definition ->
{product_definition
product_definition.frame_of_reference ->
product_definition_context <=
application_context_element
application_context_element.name = 'functional occurrence'}
(product_definition)
(product_definition =>
externally_defined_plant_item_definition))

```

#### 5.1.14.45 Plant\_item\_design\_view

AIM element: (product\_definition)  
(externally\_defined\_plant\_item\_definition)

Source: 41, 227

Rules: dependent\_instantiable\_product\_context  
product\_context\_discipline\_type\_constraint  
value\_for\_application\_context

Reference path: (product\_definition)  
(externally\_defined\_plant\_item\_definition <=  
[externally\_defined\_item]  
[product\_definition])  
{product\_definition  
[product\_definition.formation ->  
product\_definition\_formation  
product\_definition\_formation.of\_product ->  
product  
product.frame\_of\_reference[i] ->  
product\_context<=  
application\_context\_element  
application\_context\_element.name = 'plant item']  
[product\_definition.frame\_of\_reference ->  
[product\_definition\_context <=  
application\_context\_element  
(application\_context\_element.name = 'functional definition')  
(application\_context\_element.name = 'functional occurrence')  
(application\_context\_element.name = 'physical definition')  
(application\_context\_element.name = 'physical occurrence')]  
[product\_definition\_context  
(product\_definition\_context.life\_cycle\_stage = 'physical design')  
(product\_definition\_context.life\_cycle\_stage = 'functional design')]]}

**5.1.14.46 Plant\_item\_instance**

AIM element:	(product_definition) (externally_defined_plant_item_definition)
Source:	41, 227
Rules:	dependent_instantiable_product_context product_context_discipline_type_constraint value_for_application_context
Reference path:	(product_definition) (externally_defined_plant_item_definition <= [product_definition] [externally_defined_item]) {product_definition [product_definition.formation -> product_definition_formation product_definition_formation.of_product -> product product.frame_of_reference[i] -> product_context<= application_context_element application_context_element.name = 'plant item'] [product_definition.frame_of_reference -> product_definition_context <= application_context_element (application_context_element.name = 'functional occurrence') (application_context_element.name = 'physical occurrence')]]}

**5.1.14.46.1 plant\_item\_instance to plant\_item\_interference (first item)**

AIM element:	PATH
Reference path:	(product_definition <-) (externally_defined_plant_item_definition <= product_definition <-) product_definition_relationship.relateing_product_definition product_definition_relationship => plant_item_interference

**5.1.14.46.2 plant\_item\_instance to plant\_item\_interference(second item)**

AIM element:	PATH
Reference path:	(product_definition <-) (externally_defined_plant_item_definition <= product_definition <-) product_definition_relationship.related_product_definition product_definition_relationship => plant_item_interference

### 5.1.14.46.3 plant\_item\_instance to plant\_item\_location

#1: The plant item is placed relative to another plant item.

#2a: The plant item is placed in a building, plant, or site.

#2b: The plant item is defined in the coordinate space of a building, plant, or site.

AIM element: PATH

Rules: subtype\_mandatory\_shape\_representation

Reference path: (product\_definition)  
 (externally\_defined\_plant\_item\_definition <=  
 product\_definition)  
 characterized\_product\_definition = product\_definition  
 characterized\_product\_definition  
 characterized\_definition = characterized\_product\_definition  
 characterized\_definition <=  
 property\_definition.definition  
 {property\_definition =>  
 product\_definition\_shape}  
 property\_definition  
 represented\_definition = property\_definition  
 represented\_definition <=  
 property\_definition\_representation.definition  
 {property\_definition\_representation =>  
 shape\_definition\_representation}  
 property\_definition\_representation  
 property\_definition\_representation.used\_representation ->  
 {representation =>  
 shape\_representation}  
 #1: (representation <=  
 representation\_map.mapped\_representation  
 representation\_map <=  
 mapped\_item.mapping\_source  
 mapped\_item  
 {mapped\_item <=  
 representation\_item  
 representation\_item.name = 'relative item location'})  
 #2a: (  
 representation  
 representation.items[i] ->  
 {representation\_item  
 representation\_item.name = 'placed shape'}  
 representation\_item =>  
 mapped\_item  
 mapped\_item.mapping\_target ->  
 representation\_item =>  
 geometric\_representation\_item =>  
 placement =>  
 (axis2\_placement\_2d)  
 (axis2\_placement\_3d))  
 #2b: (

```

representation
representation.items[i] ->
representation_item =>
geometric_representation_item =>
placement =>
(axis2_placement_2d)
(axis2_placement_3d))

```

#### 5.1.14.46.4 plant\_item\_instance to project\_design\_assignment

AIM element: PATH

Reference path:

```

(product_definition)
(externally_defined_plant_item_definition <=
product_definition)
design_project_item = product_definition
design_project_item <-
design_project_assignment.items[i]
design_project_assignment

```

#### 5.1.14.46.5 plant\_item\_instance to relative\_item\_location

AIM element: PATH

Reference path:

```

(product_definition)
(externally_defined_plant_item_definition <=
product_definition)
characterized_product_definition = product_definition
characterized_product_definition
characterized_definition = characterized_product_definition
characterized_definition <-
property_definition.definition
{property_definition =>
product_definition_shape}
property_definition
represented_definition = property_definition
represented_definition <-
property_definition_representation.definition
property_definition_representation
property_definition_representation.used_representation ->
representation
representation.items[i] ->
{representation_item =>
geometric_representation_item =>
placement =>
(axis2_placement_2d)
(axis2_placement_3d)}
representation_item <-
mapped_item.mapping_target
mapped_item
{mapped_item <=
representation_item

```

```
representation_item.name = 'relative item location'}
```

#### 5.1.14.47 Plant\_item\_location

#1: The plant item is placed relative to another plant item.

#2: The plant item is placed in a building, plant, or site.

AIM element:      #1: (mapped\_item)  
                      #2: ((axis2\_placement\_2d)  
                          (axis2\_placement\_3d))

Source:            43, 42

##### 5.1.14.47.1 location\_and\_orientation

#1: The plant item is placed relative to another plant item.

#2: The plant item is placed in a building, plant, or site.

AIM element:      [(axis2\_placement\_2d)  
                      (axis2\_placement\_3d)]  
                      [cartesian\_point]

Source:            42

Reference path:    #1: (mapped\_item  
                      mapped\_item.mapping\_target ->  
                      representation\_item =>  
                      geometric\_representation\_item =>  
                      [placement =>  
                      (axis2\_placement\_2d)  
                      (axis2\_placement\_3d)]  
                      [placement  
                      placement.location ->  
                      cartesian\_point])  
                      #2: ([ (axis2\_placement\_2d)  
                      (axis2\_placement\_3d)]  
                      [(axis2\_placement\_2d <=)  
                      (axis2\_placement\_3d <=)  
                      placement  
                      placement.location ->  
                      cartesian\_point])

##### 5.1.14.47.2 location\_id

#1: The plant item is placed relative to another plant item.

#2: The plant item is placed in a building, plant, or site.

AIM element:      representation\_item.name

Source: 43

Reference path: #1: (mapped\_item  
mapped\_item.mapping\_target ->  
{representation\_item =>  
geometric\_representation\_item =>  
placement =>  
(axis2\_placement\_2d)  
(axis2\_placement\_3d)})  
#2: ((axis2\_placement\_2d <=)  
(axis2\_placement\_3d <=)  
placement <=  
geometric\_representation\_item <=)  
representation\_item  
representation\_item.name

### 5.1.14.47.3 plant\_item\_location to changed\_plant\_item\_location

#1: The plant item is placed relative to another plant item.

#2: The plant item is placed in a building, plant, or site.

AIM element: #1: (PATH)  
#2: (IDENTICAL MAPPING)

Source:

Reference path: #1: mapped\_item  
mapped\_item.mapping\_target ->  
representation\_item =>  
geometric\_representation\_item =>  
placement =>  
(axis2\_placement\_2d  
{axis2\_placement\_2d  
change\_item = axis2\_placement\_2d})  
(axis2\_placement\_3d  
{axis2\_placement\_3d  
change\_item = axis2\_placement\_3d})

### 5.1.14.48 Plant\_item\_weight

AIM element: plant\_item\_weight\_representation

Source: 227

Reference path: plant\_item\_weight\_representation <=  
property\_definition\_representation  
{property\_definition\_representation  
property\_definition\_representation.used\_representation ->  
representation  
representation.name = 'item weight'}

**5.1.14.48.1 centre\_of\_gravity**

AIM element: geometric\_representation\_item

Source: 42

Reference path: plant\_item\_weight\_representation <=  
property\_definition\_representation  
property\_definition\_representation.used\_representation ->  
representation  
representation.items[i] ->  
{representation\_item  
representation\_item.name = 'centre of gravity'}  
representation\_item =>  
geometric\_representation\_item

**5.1.14.48.2 weight\_state**

AIM element: type\_qualifier.name

Source: 45

Reference path: plant\_item\_weight\_representation <=  
property\_definition\_representation  
property\_definition\_representation.used\_representation ->  
representation  
representation.items[i] ->  
({[representation\_item  
representation\_item.name = 'weight value']  
[representation\_item =>  
measure\_representation\_item]})  
representation\_item =>  
qualified\_representation\_item  
qualified\_representation\_item.qualifiers[i] ->  
value\_qualifier  
value\_qualifier = type\_qualifier  
type\_qualifier  
{(type\_qualifier.name = 'empty')  
(type\_qualifier.name = 'full')  
(type\_qualifier.name = 'operating')  
(type\_qualifier.name = 'shipping')  
(type\_qualifier.name = 'test')})  
({[representation\_item  
(representation\_item.name = 'maximum weight value')  
(representation\_item.name = 'minimum weight value')]  
[representation\_item =>  
measure\_representation\_item]})  
representation\_item =>  
qualified\_representation\_item  
qualified\_representation\_item.qualifiers[i] ->  
value\_qualifier  
value\_qualifier = type\_qualifier  
type\_qualifier

```
type_qualifier.name = 'operating'))
```

### 5.1.14.48.3 weight\_value

AIM element: [measure\_with\_unit.value\_component]  
[measure\_with\_unit.unit\_component]

Source: 41

Reference path: plant\_item\_weight\_representation <=  
property\_definition\_representation  
property\_definition\_representation.used\_representation ->  
representation  
(representation.items[i] ->  
{representation\_item  
(representation\_item.name = 'weight value')  
(representation\_item.name = 'maximum weight value')  
(representation\_item.name = 'minimum weight value'))}  
([representation.items[i] ->  
{representation\_item  
representation\_item.name = 'maximum weight value'}]  
[representation.items[i] ->  
{representation\_item  
representation\_item.name = 'minimum weight value'}}]  
{representation\_item =>  
qualified\_representation\_item}  
representation\_item =>  
measure\_representation\_item <=  
measure\_with\_unit  
[measure\_with\_unit.value\_component]  
[{measure\_with\_unit.unit\_component ->  
unit  
unit = derived\_unit}  
measure\_with\_unit.unit\_component]

### 5.1.14.49 Plant\_volume

AIM element: (plant\_item\_route)  
(reserved\_space)  
(system\_space)  
(product\_definition\_shape)  
(shape\_aspect)

Source: 227

Rules: dependent\_instantiable\_product\_context  
product\_context\_discipline\_type\_constraint  
value\_for\_application\_context

Reference path: ((plant\_item\_route <=  
product\_definition\_shape)  
(product\_definition\_shape)  
{product\_definition\_shape <=

```

property_definition
property_definition.definition ->
characterized_definition
characterized_definition = characterized_product_definition
characterized_product_definition
characterized_product_definition = product_definition
product_definition
product_definition.formation ->
product_definition_formation
product_definition_formation.of_product ->
product
product.frame_of_reference[i] ->
product_context<=
application_context_element
application_context_element.name = 'plant item'})
((reserved_space <=
shape_aspect)
(shape_aspect)
{shape_aspect
shape_aspect.of_shape ->
product_definition_shape <=
property_definition
property_definition.definition ->
characterized_definition
characterized_definition = characterized_product_definition
characterized_product_definition
characterized_product_definition = product_definition
product_definition
product_definition.formation ->
product_definition_formation
product_definition_formation.of_product ->
product
product.frame_of_reference[i] ->
product_context<=
application_context_element
application_context_element.name = 'plant item'})
(system_space <=
product_definition_shape
{product_definition_shape <=
property_definition
property_definition.definition ->
characterized_definition
characterized_definition = characterized_product_definition
characterized_product_definition
characterized_product_definition = product_definition
product_definition
product_definition.formation ->
product_definition_formation
product_definition_formation.of_product ->
product
product.frame_of_reference[i] ->
product_context<=
application_context_element

```

```
application_context_element.name = 'plant system'))
```

### 5.1.14.49.1 type

AIM element: (property\_definition.name)  
(shape\_aspect.name)

Source: 41

Reference path: ((plant\_item\_route <=  
product\_definition\_shape <=)  
(system\_space <=  
product\_definition\_shape <=)  
(product\_definition\_shape <=)  
property\_definition  
property\_definition.name)  
((reserved\_space <=  
shape\_aspect)  
(shape\_aspect)  
shape\_aspect.name)

### 5.1.14.50 Process\_ducting

AIM element: piping\_component\_definition

Source: 227

Rules: dependent\_instantiable\_product\_context  
product\_context\_discipline\_type\_constraint  
value\_for\_application\_context

Reference path: piping\_component\_definition <=  
product\_definition  
{product\_definition  
product\_definition.formation ->  
product\_definition\_formation  
product\_definition\_formation.of\_product ->  
[product  
classification\_item = product  
classification\_item <-  
applied\_classification\_assignment.items[i]  
applied\_classification\_assignment <=  
classification\_assignment  
classification\_assignment.assigned\_classification ->  
[group  
group.name = 'process ducting']  
[group <-  
group\_relationship.related\_group  
{group\_relationship  
group\_relationship.name = 'usage classification'}  
group\_relationship  
group\_relationship.relating\_group ->

```

group
group.name = 'ducting component']]
[product
product.frame_of_reference[i] ->
product_context<=
application_context_element
application_context_element.name = 'plant item']]

```

### 5.1.14.50.1 gauge

AIM element: [measure\_with\_unit.value\_component]  
[measure\_with\_unit.unit\_component]

Source: 41

Rules: subtype\_mandatory\_shape\_representation

Reference path: piping\_component\_definition <=  
product\_definition  
characterized\_product\_definition = product\_definition  
characterized\_product\_definition  
characterized\_definition = characterized\_product\_definition  
characterized\_definition <=  
property\_definition.definition  
property\_definition =>  
product\_definition\_shape <=  
shape\_aspect.of\_shape  
[shape\_aspect <=  
shape\_aspect\_relationship.relate\_shape\_aspect]  
[shape\_aspect <=  
shape\_aspect\_relationship.related\_shape\_aspect]  
shape\_aspect\_relationship =>  
dimensional\_location  
dimensional\_characteristic = dimensional\_location  
dimensional\_characteristic <=  
dimensional\_characteristic\_representation.dimension  
dimensional\_characteristic\_representation  
dimensional\_characteristic\_representation.representation ->  
shape\_dimension\_representation <=  
shape\_representation <=  
{representation  
representation.name = 'process ducting dimensional shape'}  
representation  
representation.items[i] ->  
{representation\_item  
representation\_item.name = 'gauge'}  
representation\_item =>  
measure\_representation\_item <=  
{measure\_with\_unit =>  
length\_measure\_with\_unit}  
measure\_with\_unit  
[measure\_with\_unit.value\_component]  
[measure\_with\_unit.unit\_component]

**5.1.14.51 Project\_design\_assignment**

AIM element: design\_project\_assignment

Source: 227

Reference path: design\_project\_assignment <=  
 organization\_assignment  
 {organization\_assignment  
 organization\_assignment.assigned\_organization ->  
 organization =>  
 design\_project}

**5.1.14.52 Relative\_item\_location**

AIM element: mapped\_item

Source: 43

Reference path: {[mapped\_item <=  
 representation\_item  
 representation\_item.name = 'relative item location']  
 [mapped\_item  
 mapped\_item.mapping\_target ->  
 [representation\_item =>  
 geometric\_representation\_item =>  
 placement =>  
 (axis2\_placement\_2d)  
 (axis2\_placement\_3d)]  
 [representation\_item <=  
 representation.items[i]  
 representation <=  
 property\_definition\_representation.used\_representation  
 property\_definition\_representation  
 property\_definition\_representation.definition ->  
 represented\_definition  
 represented\_definition = property\_definition  
 property\_definition  
 property\_definition.definition ->  
 characterized\_definition  
 characterized\_definition = characterized\_product\_definition  
 characterized\_product\_definition  
 characterized\_product\_definition = product\_definition  
 product\_definition  
 product\_definition.frame\_of\_reference ->  
 product\_definition\_context <=  
 application\_context\_element  
 (application\_context\_element.name = 'functional occurrence')  
 (application\_context\_element.name = 'physical occurrence')]]}]}

**5.1.14.53 Required\_material\_description**

AIM element: product\_definition

Source: 41

Reference path: {product\_definition  
product\_definition.frame\_of\_reference ->  
{product\_definition\_context  
product\_definition\_context.life\_cycle\_stage = 'requirement definition'}  
product\_definition\_context =>  
application\_context\_element  
application\_context\_element.name = 'material'}

#### 5.1.14.53.1 description

AIM element: property\_definition.description

Source: 41

Reference path: product\_definition  
characterized\_product\_definition = product\_definition  
characterized\_product\_definition  
characterized\_definition = characterized\_product\_definition  
characterized\_definition <-  
property\_definition.definition  
{property\_definition =>  
material\_property}  
property\_definition <-  
property\_definition\_relationship.relateing\_property\_definition  
{property\_definition\_relationship  
property\_definition\_relationship.name = 'requirement allocation'}  
property\_definition\_relationship  
property\_definition\_relationship.related\_property\_definition ->  
{property\_definition =>  
material\_property =>  
required\_material\_property}  
property\_definition  
property\_definition.description

#### 5.1.14.53.2 material\_requirement\_id

AIM element: product.id

Source: 41

Reference path: product\_definition  
product\_definition.formation ->  
product\_definition\_formation  
product\_definition\_formation.of\_product ->  
product  
product.id

**5.1.14.53.3 required\_material\_description to changed\_required\_material\_-description**

AIM element: IDENTICAL MAPPING

**5.1.14.53.4 required\_material\_description to material\_specification\_-selection**

AIM element: PATH

Reference path: product\_definition  
 [characterized\_product\_definition = product\_definition  
 characterized\_product\_definition  
 characterized\_definition = characterized\_product\_definition  
 characterized\_definition <-  
 property\_definition.definition  
 property\_definition =>  
 material\_property]  
 [document\_item = product\_definition  
 document\_item <-  
 applied\_document\_reference.items[i]  
 applied\_document\_reference <=  
 document\_reference  
 document\_reference.assigned\_document ->  
 document]

**5.1.14.54 Reserved\_space**

AIM element: reserved\_space

Source: 227

Rules: dependent\_instantiable\_product\_context  
 product\_context\_discipline\_type\_constraint  
 value\_for\_application\_context

Reference path: reserved\_space <=  
 shape\_aspect  
 {shape\_aspect  
 shape\_aspect.of\_shape ->  
 product\_definition\_shape <=  
 property\_definition  
 property\_definition.definition ->  
 characterized\_definition  
 characterized\_definition = characterized\_product\_definition  
 characterized\_product\_definition  
 characterized\_product\_definition = product\_definition  
 product\_definition  
 [product\_definition.frame\_of\_reference ->  
 product\_definition\_context <=  
 application\_context\_element  
 (application\_context\_element.name = 'functional occurrence')

```
(application_context_element.name = 'physical occurrence')]
[product_definition.formation ->
product_definition_formation
product_definition_formation.of_product ->
product
product.frame_of_reference[i] ->
product_context<=
application_context_element
application_context_element.name = 'plant item']]}
```

### 5.1.14.55 Route

AIM element: plant\_item\_route

Source: 227

Rules: dependent\_instantiable\_product\_context  
product\_context\_discipline\_type\_constraint  
value\_for\_application\_context

Reference path: plant\_item\_route <=  
product\_definition\_shape  
{product\_definition\_shape <=  
property\_definition  
property\_definition.definition ->  
characterized\_definition  
characterized\_definition = characterized\_product\_definition  
characterized\_product\_definition  
characterized\_product\_definition = product\_definition  
product\_definition  
[product\_definition.frame\_of\_reference ->  
product\_definition\_context <=  
application\_context\_element  
application\_context\_element.name = 'physical occurrence']  
[product\_definition.formation ->  
product\_definition\_formation  
product\_definition\_formation.of\_product ->  
product  
product.frame\_of\_reference[i] ->  
product\_context<=  
application\_context\_element  
application\_context\_element.name = 'plant item']]}

#### 5.1.14.55.1 route to piping\_system\_line\_segment

AIM element: PATH

Rules: product\_definition\_usage\_constraint

Reference path: plant\_item\_route <=  
product\_definition\_shape <=  
property\_definition  
property\_definition.definition ->

```

characterized_definition
characterized_definition = characterized_product_definition
characterized_product_definition
characterized_product_definition = product_definition
product_definition <-
product_definition_relationship.related_product_definition
product_definition_relationship
product_definition_relationship.relying_product_definition
product_definition =>
plant_line_segment_definition

```

#### 5.1.14.56 Spare\_plant\_item\_usage

AIM element: product\_definition\_relationship

Source: 41

Reference path: {product\_definition\_relationship  
product\_definition\_relationship.name = 'spare plant item usage'}

#### 5.1.14.57 Spring\_washer

AIM element: bolt\_and\_nut\_component\_definition

Source: 227

Rules: dependent\_instantiable\_product\_context  
product\_context\_discipline\_type\_constraint  
value\_for\_application\_context

Reference path: bolt\_and\_nut\_component\_definition <=  
product\_definition  
{bolt\_and\_nut\_component\_definition  
classification\_item = piping\_support\_definition  
classification\_item <=  
applied\_classification\_assignment.items[i]  
applied\_classification\_assignment <=  
classification\_assignment  
classification\_assignment.assigned\_classification ->  
[group =>  
bolt\_and\_nut\_component\_class]  
[group  
group.name = 'spring washer']  
[group <=  
group\_relationship.related\_group  
group\_relationship  
{group\_relationship.name = 'class hierarchy'}  
group\_relationship.relying\_group ->  
group  
{[group.name = 'washer']  
[group =>  
bolt\_and\_nut\_component\_class]}}  
{product\_definition

```

product_definition.formation ->
product_definition_formation
product_definition_formation.of_product ->
[product
classification_item = product
classification_item <-
applied_classification_assignment.items[i]
applied_classification_assignment <=
classification_assignment
classification_assignment.assigned_classification ->
(group)
(group <-
group_relationship.related_group
group_relationship
group_relationship.relatng_group ->
group)
group.name = 'bolt and nut component']
[product
product.frame_of_reference[i] ->
product_context <=
application_context_element
application_context_element.name = 'plant item']]

```

#### 5.1.14.57.1 thickness

AIM element:	[measure_with_unit.value_component] [measure_with_unit.unit_component]
Source:	41
Rules:	subtype_mandatory_shape_representation
Reference path:	bolt_and_nut_component_definition <= product_definition characterized_product_definition = product_definition characterized_product_definition characterized_definition = characterized_product_definition characterized_definition <- property_definition.definition property_definition => product_definition_shape <- shape_aspect.of_shape [shape_aspect <- shape_aspect_relationship.relatng_shape_aspect] [shape_aspect <- shape_aspect_relationship.related_shape_aspect] shape_aspect_relationship => dimensional_location dimensional_characteristic = dimensional_location dimensional_characteristic <- dimensional_characteristic_representation.dimension dimensional_characteristic_representation dimensional_characteristic_representation.representation -> shape_dimension_representation <=

```

shape_representation <=
{representation
representation.name = 'spring washer dimensional shape'}
representation
representation.items[i] ->
representation_item =>
{representation_item.name = 'thickness'}
measure_representation_item <=
{measure_with_unit =>
length_measure_with_unit}
measure_with_unit
[measure_with_unit.value_component]
[measure_with_unit.unit_component]

```

### 5.1.14.57.2 outside\_diameter

AIM element: [measure\_with\_unit.value\_component]  
[measure\_with\_unit.unit\_component]

Source: 41

Rules: subtype\_mandatory\_shape\_representation

Reference path: bolt\_and\_nut\_component\_definition <=

```

product_definition
characterized_product_definition = product_definition
characterized_product_definition
characterized_definition = characterized_product_definition
characterized_definition <-
property_definition.definition
property_definition =>
product_definition_shape <-
shape_aspect.of_shape
[shape_aspect <-
shape_aspect.relationship.relate_shape_aspect]
[shape_aspect <-
shape_aspect.relationship.related_shape_aspect]
shape_aspect_relationship =>
dimensional_location
dimensional_characteristic = dimensional_location
dimensional_characteristic <-
dimensional_characteristic_representation.dimension
dimensional_characteristic_representation
dimensional_characteristic_representation.representation ->
shape_dimension_representation <=
shape_representation <=
{representation
representation.name = 'spring washer dimensional shape'}
representation
representation.items[i] ->
representation_item =>
{representation_item.name = 'outside diameter'}
measure_representation_item <=
{measure_with_unit =>

```

```
length_measure_with_unit}
measure_with_unit
[measure_with_unit.value_component]
[measure_with_unit.unit_component]
```

### 5.1.14.58 Structural\_component

AIM element: product

Source: 41

Rules: dependent\_instantiable\_product\_context  
product\_context\_discipline\_type\_constraint  
value\_for\_application\_context

Reference path: {[product  
classification\_item = product  
classification\_item <-  
applied\_classification\_assignment.items[i]  
applied\_classification\_assignment <=  
classification\_assignment  
classification\_assignment.assigned\_classification ->  
group  
group.name = 'structural component']  
[product  
product.frame\_of\_reference[i] ->  
product\_context<=  
application\_context\_element  
application\_context\_element.name = 'plant item']]}

#### 5.1.14.58.1 exact\_section

AIM element: shape\_aspect

Source: 41

Reference path: product <-  
product\_definition\_formation.of\_product  
product\_definition\_formation <-  
product\_definition.formation  
product\_definition  
characterized\_product\_definition = product\_definition  
characterized\_product\_definition  
characterized\_definition = characterized\_product\_definition  
characterized\_definition <-  
property\_definition.definition  
property\_definition =>  
product\_definition\_shape <-  
shape\_aspect.of\_shape  
shape\_aspect

**5.1.14.58.2 size\_designator**

AIM element: descriptive\_representation\_item.description

Source: 45

Reference path: product <-  
 product\_definition\_formation.of\_product  
 product\_definition\_formation <-  
 product\_definition.formation  
 product\_definition  
 characterized\_product\_definition = product\_definition  
 characterized\_product\_definition  
 characterized\_definition = characterized\_product\_definition  
 characterized\_definition <-  
 property\_definition.definition  
 property\_definition  
 represented\_definition = property\_definition  
 represented\_definition <-  
 property\_definition\_representation.definition  
 property\_definition\_representation  
 property\_definition\_representation.used\_representation ->  
 {representation  
 document\_item = representation  
 document\_item <-  
 applied\_document\_reference.items[i]  
 applied\_document\_reference <=  
 document\_reference  
 document\_reference.assigned\_document ->  
 document}  
 representation  
 representation.items[i] ->  
 {representation\_item  
 representation\_item.name = 'size designator'}  
 representation\_item =>  
 descriptive\_representation\_item  
 descriptive\_representation\_item.description

**5.1.14.58.3 type**

AIM element: group.name

Source: 41

Reference path: product  
 classification\_item = product  
 classification\_item <-  
 applied\_classification\_assignment.items[i]  
 applied\_classification\_assignment <=  
 {classification\_assignment  
 classification\_assignment.role ->  
 classification\_role  
 classification\_role.name = 'structural component type classification'}  
 classification\_assignment

```

classification_assignment.assigned_classification ->
group
group.name

```

### 5.1.14.59 Stud\_bolt

AIM element: bolt\_and\_nut\_component\_definition

Source: 227

Rules: dependent\_instantiable\_product\_context  
product\_context\_discipline\_type\_constraint  
value\_for\_application\_context

Reference path: bolt\_and\_nut\_component\_definition <=  
product\_definition  
{bolt\_and\_nut\_component\_definition  
classification\_item = piping\_support\_definition  
classification\_item <=  
applied\_classification\_assignment.items[i]  
applied\_classification\_assignment <=  
classification\_assignment  
classification\_assignment.assigned\_classification ->  
[group =>  
bolt\_and\_nut\_component\_class]  
[group  
group.name = 'stud bolt']  
[group <=  
group\_relationship.related\_group  
group\_relationship  
{group\_relationship.name = 'class hierarchy'}  
group\_relationship.relate\_group ->  
group  
{[group.name = 'bolt']  
[group =>  
bolt\_and\_nut\_component\_class]}}  
{product\_definition  
product\_definition.formation ->  
product\_definition\_formation  
product\_definition\_formation.of\_product ->  
[product  
classification\_item = product  
classification\_item <=  
applied\_classification\_assignment.items[i]  
applied\_classification\_assignment <=  
classification\_assignment  
classification\_assignment.assigned\_classification ->  
(group)  
(group <=  
group\_relationship.related\_group  
group\_relationship  
group\_relationship.relate\_group ->  
group)  
group.name = 'bolt and nut component']

```
[product
product.frame_of_reference[i] ->
product_context <=
application_context_element
application_context_element.name = 'plant item']])
```

### 5.1.14.59.1 length

AIM element: [measure\_with\_unit.value\_component]  
[measure\_with\_unit.unit\_component]

Source: 41

Rules: subtype\_mandatory\_shape\_representation

Reference path: bolt\_and\_nut\_component\_definition <=  
product\_definition  
characterized\_product\_definition = product\_definition  
characterized\_product\_definition  
characterized\_definition = characterized\_product\_definition  
characterized\_definition <=  
property\_definition.definition  
property\_definition =>  
product\_definition\_shape <=  
shape\_aspect.of\_shape  
[shape\_aspect <=  
shape\_aspect\_relationship.relate\_shape\_aspect]  
[shape\_aspect <=  
shape\_aspect\_relationship.related\_shape\_aspect]  
shape\_aspect\_relationship =>  
dimensional\_location  
dimensional\_characteristic = dimensional\_location  
dimensional\_characteristic <=  
dimensional\_characteristic\_representation.dimension  
dimensional\_characteristic\_representation  
dimensional\_characteristic\_representation.representation ->  
shape\_dimension\_representation <=  
shape\_representation <=  
{representation  
representation.name = 'stud bolt dimensional shape'}  
representation  
representation.items[i] ->  
representation\_item =>  
{representation\_item.name = 'length'}  
measure\_representation\_item <=  
{measure\_with\_unit =>  
length\_measure\_with\_unit}  
measure\_with\_unit  
[measure\_with\_unit.value\_component]  
[measure\_with\_unit.unit\_component]

### 5.1.14.60 Supplied\_equipment

AIM element: product

Source: 41

Reference path: {[product <-  
product\_definition\_formation.of\_product  
product\_definition\_formation =>  
product\_definition\_formation\_with\_specified\_source  
product\_definition\_formation\_with\_specified\_source.make\_or\_buy = 'BUY']  
[product  
classification\_item = product  
classification\_item <-  
applied\_classification\_assignment.items[i]  
applied\_classification\_assignment <=  
classification\_assignment  
classification\_assignment.assigned\_classification ->  
group  
group.name = 'equipment']]}

#### 5.1.14.60.1 delivery\_date

AIM element: (date\_assignment.role)  
(date\_and\_time\_assignment.role)

Source: 41

Reference path: product  
(dated\_item = product  
dated\_item <-  
applied\_date\_assignment.items[i]  
applied\_date\_assignment <=  
date\_assignment  
date\_assignment.role)  
(date\_and\_time\_item = product  
date\_and\_time\_item <-  
applied\_date\_and\_time\_assignment.items[i]  
applied\_date\_and\_time\_assignment <=  
date\_and\_time\_assignment  
date\_and\_time\_assignment.role)

#### 5.1.14.60.2 purchase\_order\_number

AIM element: action\_directive.name

Source: 41

Reference path: product  
purchase\_item = product  
purchase\_item <-  
purchase\_assignment.items[i]  
purchase\_assignment <=  
action\_assignment  
action\_assignment.assigned\_action ->

```

action =>
executed_action =>
directed_action
directed_action.directive ->
action_directive
action_directive.name

```

### 5.1.14.60.3 requisition\_number

#1: Prior to purchase order being issue.

#2: A purchase order exists.

AIM element: versioned\_action\_request.id

Source: 41

Reference path:

```

product
#1: (action_request_item = product
action_request_item <-
applied_action_request_assignment.items[i]
applied_action_request_assignment <=
action_request_assignment
action_request_assignment.assigned_action_request ->)
#2: (purchase_item = product
purchase_item <-
purchase_assignment.items[i]
purchase_assignment <=
action_assignment
action_assignment.assigned_action ->
action =>
executed_action =>
directed_action
directed_action.directive ->
action_directive
action_directive.requests[i] ->)
versioned_action_request
versioned_action_request.id

```

### 5.1.14.61 Supplier

AIM element: organization

Source: 41

#### 5.1.14.61.1 supplier\_id

AIM element: organization.id

Source: 41

**5.1.14.61.2 vendor\_name**

AIM element: organization.name

Source: 41

**5.1.14.61.3 supplier to catalogue\_definition**

AIM element: PATH

Reference path: organization <-  
 organization\_assignment.assigned\_organization  
 {organization\_assignment  
 organization\_assignment.role ->  
 organization\_role  
 organization\_role.name = 'publisher'}  
 organization\_assignment =>  
 plant\_spatial\_configuration\_organization\_assignment  
 plant\_spatial\_configuration\_organization\_assignment.items[i] ->  
 plant\_spatial\_configuration\_organization\_item  
 plant\_spatial\_configuration\_organization\_item = catalogue  
 catalogue

**5.1.14.61.4 supplier to supplied\_equipment**

AIM element: PATH

Reference path: organization <-  
 organization\_assignment.assigned\_organization  
 {organization\_assignment  
 organization\_assignment.role ->  
 organization\_role  
 organization\_role.name = 'supplier'}  
 organization\_assignment =>  
 plant\_spatial\_configuration\_organization\_assignment  
 plant\_spatial\_configuration\_organization\_assignment.items[i] ->  
 plant\_spatial\_configuration\_organization\_item  
 plant\_spatial\_configuration\_organization\_item = product\_definition\_formation  
 {product\_definition\_formation =>  
 product\_definition\_formation\_with\_specified\_source}  
 product\_definition\_formation  
 product\_definition\_formation.of\_product ->  
 product  
 {product  
 classification\_item = product  
 classification\_item <-  
 applied\_classification\_assignment.items[i]  
 applied\_classification\_assignment <=  
 classification\_assignment  
 classification\_assignment.assigned\_classification ->  
 group  
 group.name = 'equipment'}

**5.1.14.62 Support\_component**

AIM element:	product
Source:	41
Rules:	dependent_instantiable_product_context product_context_discipline_type_constraint value_for_application_context
Reference path:	{[product classification_item = product classification_item <- applied_classification_assignment.items[i] applied_classification_assignment <= classification_assignment classification_assignment.assigned_classification -> group group.name = 'support component'] [product product.frame_of_reference[i] -> product_context<= application_context_element application_context_element.name = 'plant item']}

**5.1.14.63 Support\_constraints**

AIM element:	support_constraint_representation
Source:	227
Reference path:	support_constraint_representation <= representation

**5.1.14.63.1 gap**

AIM element:	[measure_with_unit.value_component] [measure_with_unit.unit_component]
Source:	41
Reference path:	support_constraint_representation <= representation representation.items[i] -> {representation_item (representation_item.name = 'negative x') (representation_item.name = 'positive x') (representation_item.name = 'negative y') (representation_item.name = 'positive y') (representation_item.name = 'negative z') (representation_item.name = 'positive z') (representation_item.name = 'negative x rotation') (representation_item.name = 'positive x rotation')}

```

(representation_item.name = 'negative y rotation')
(representation_item.name = 'positive y rotation')
(representation_item.name = 'negative z rotation')
(representation_item.name = 'positive z rotation')
representation_item =>
measure_representation_item <=
{measure_with_unit =>
length_measure_with_unit}
measure_with_unit
[measure_with_unit.value_component]
[measure_with_unit.unit_component]

```

#### 5.1.14.63.2 k

AIM element: [measure\_with\_unit.value\_component]  
[measure\_with\_unit.unit\_component]

Source: 41

Reference path: support\_constraint\_representation <=  
representation  
representation.items[i] ->  
representation\_item =>  
measure\_representation\_item <=  
{measure\_with\_unit =>  
ratio\_measure\_with\_unit}  
measure\_with\_unit  
[measure\_with\_unit.value\_component]  
[measure\_with\_unit.unit\_component]

#### 5.1.14.63.3 restrained

AIM element: descriptive\_representation\_item.description

Source: 45

Reference path: support\_constraint\_representation <=  
representation  
representation.items[i] ->  
representation\_item =>  
descriptive\_representation\_item  
descriptive\_representation\_item.description

#### 5.1.14.63.4 support\_constraint\_id

AIM element: representation.name

Source: 43

Reference path: support\_constraint\_representation <=  
representation  
representation.name

**5.1.14.63.5 support\_constraints to support\_usage (negative x-direction)**

AIM element: PATH

Reference path: support\_constraint\_representation <=  
 {representation  
 representation.items[i] ->  
 representation\_item  
 representation\_item.name = 'negative x'}  
 representation <-  
 property\_definition\_representation.used\_representation  
 property\_definition\_representation  
 property\_definition\_representation.definition ->  
 represented\_definition  
 represented\_definition = property\_definition  
 property\_definition  
 property\_definition.definition ->  
 characterized\_definition  
 characterized\_definition = characterized\_product\_definition  
 characterized\_product\_definition  
 characterized\_product\_definition = product\_definition\_relationship  
 {product\_definition\_relationship  
 (product\_definition\_relationship.name = 'support usage')  
 (product\_definition\_relationship.name = 'support usage connection')}  
 product\_definition\_relationship

**5.1.14.63.6 support\_constraints to support\_usage (positive x-direction)**

AIM element: PATH

Reference path: support\_constraint\_representation <=  
 {representation  
 representation.items[i] ->  
 representation\_item  
 representation\_item.name = 'positive x'}  
 representation <-  
 property\_definition\_representation.used\_representation  
 property\_definition\_representation  
 property\_definition\_representation.definition ->  
 represented\_definition  
 represented\_definition = property\_definition  
 property\_definition  
 property\_definition.definition ->  
 characterized\_definition  
 characterized\_definition = characterized\_product\_definition  
 characterized\_product\_definition  
 characterized\_product\_definition = product\_definition\_relationship  
 {product\_definition\_relationship  
 (product\_definition\_relationship.name = 'support usage')  
 (product\_definition\_relationship.name = 'support usage connection')}  
 product\_definition\_relationship

**5.1.14.63.7 support\_constraints to support\_usage (negative y-direction)**

AIM element: PATH

Reference path: support\_constraint\_representation <=  
 {representation  
 representation.items[i] ->  
 representation\_item  
 representation\_item.name = 'negative y'}  
 representation <-  
 property\_definition\_representation.used\_representation  
 property\_definition\_representation  
 property\_definition\_representation.definition ->  
 represented\_definition  
 represented\_definition = property\_definition  
 property\_definition  
 property\_definition.definition ->  
 characterized\_definition  
 characterized\_definition = characterized\_product\_definition  
 characterized\_product\_definition  
 characterized\_product\_definition = product\_definition\_relationship  
 {product\_definition\_relationship  
 (product\_definition\_relationship.name = 'support usage')  
 (product\_definition\_relationship.name = 'support usage connection')}  
 product\_definition\_relationship

**5.1.14.63.8 support\_constraints to support\_usage (positive y-direction)**

AIM element: PATH

Reference path: support\_constraint\_representation <=  
 {representation  
 representation.items[i] ->  
 representation\_item  
 representation\_item.name = 'positive y'}  
 representation <-  
 property\_definition\_representation.used\_representation  
 property\_definition\_representation  
 property\_definition\_representation.definition ->  
 represented\_definition  
 represented\_definition = property\_definition  
 property\_definition  
 property\_definition.definition ->  
 characterized\_definition  
 characterized\_definition = characterized\_product\_definition  
 characterized\_product\_definition  
 characterized\_product\_definition = product\_definition\_relationship  
 {product\_definition\_relationship  
 (product\_definition\_relationship.name = 'support usage')  
 (product\_definition\_relationship.name = 'support usage connection')}  
 product\_definition\_relationship

**5.1.14.63.9 support\_constraints to support\_usage (negative z-direction)**

AIM element: PATH

Reference path: support\_constraint\_representation <=  
 {representation  
 representation.items[i] ->  
 representation\_item  
 representation\_item.name = 'negative z'}  
 representation <-  
 property\_definition\_representation.used\_representation  
 property\_definition\_representation  
 property\_definition\_representation.definition ->  
 represented\_definition  
 represented\_definition = property\_definition  
 property\_definition  
 property\_definition.definition ->  
 characterized\_definition  
 characterized\_definition = characterized\_product\_definition  
 characterized\_product\_definition  
 characterized\_product\_definition = product\_definition\_relationship  
 {product\_definition\_relationship  
 (product\_definition\_relationship.name = 'support usage')  
 (product\_definition\_relationship.name = 'support usage connection')}  
 product\_definition\_relationship

**5.1.14.63.10 support\_constraints to support\_usage (positive z-direction)**

AIM element: PATH

Reference path: support\_constraint\_representation <=  
 {representation  
 representation.items[i] ->  
 representation\_item  
 representation\_item.name = 'positive z'}  
 representation <-  
 property\_definition\_representation.used\_representation  
 property\_definition\_representation  
 property\_definition\_representation.definition ->  
 represented\_definition  
 represented\_definition = property\_definition  
 property\_definition  
 property\_definition.definition ->  
 characterized\_definition  
 characterized\_definition = characterized\_product\_definition  
 characterized\_product\_definition  
 characterized\_product\_definition = product\_definition\_relationship  
 {product\_definition\_relationship  
 (product\_definition\_relationship.name = 'support usage')  
 (product\_definition\_relationship.name = 'support usage connection')}  
 product\_definition\_relationship

**5.1.14.63.11 support\_constraints to support\_usage (negative rotation x-axis)**

AIM element: PATH

Reference path: support\_constraint\_representation <=  
 {representation  
 representation.items[i] ->  
 representation\_item  
 representation\_item.name = 'negative x rotation'}  
 representation <-  
 property\_definition\_representation.used\_representation  
 property\_definition\_representation  
 property\_definition\_representation.definition ->  
 represented\_definition  
 represented\_definition = property\_definition  
 property\_definition  
 property\_definition.definition ->  
 characterized\_definition  
 characterized\_definition = characterized\_product\_definition  
 characterized\_product\_definition  
 characterized\_product\_definition = product\_definition\_relationship  
 {product\_definition\_relationship  
 (product\_definition\_relationship.name = 'support usage')  
 (product\_definition\_relationship.name = 'support usage connection')}  
 product\_definition\_relationship

**5.1.14.63.12 support\_constraints to support\_usage (positive rotation x-axis)**

AIM element: PATH

Reference path: support\_constraint\_representation <=  
 {representation  
 representation.items[i] ->  
 representation\_item  
 representation\_item.name = 'positive x rotation'}  
 representation <-  
 property\_definition\_representation.used\_representation  
 property\_definition\_representation  
 property\_definition\_representation.definition ->  
 represented\_definition  
 represented\_definition = property\_definition  
 property\_definition  
 property\_definition.definition ->  
 characterized\_definition  
 characterized\_definition = characterized\_product\_definition  
 characterized\_product\_definition  
 characterized\_product\_definition = product\_definition\_relationship  
 {product\_definition\_relationship  
 (product\_definition\_relationship.name = 'support usage')  
 (product\_definition\_relationship.name = 'support usage connection')}  
 product\_definition\_relationship

**5.1.14.63.13 support\_constraints to support\_usage (negative rotation y-axis)**

AIM element: PATH

Reference path: support\_constraint\_representation <=  
 {representation  
 representation.items[i] ->  
 representation\_item  
 representation\_item.name = 'negative y rotation'}  
 representation <-  
 property\_definition\_representation.used\_representation  
 property\_definition\_representation  
 property\_definition\_representation.definition ->  
 represented\_definition  
 represented\_definition = property\_definition  
 property\_definition  
 property\_definition.definition ->  
 characterized\_definition  
 characterized\_definition = characterized\_product\_definition  
 characterized\_product\_definition  
 characterized\_product\_definition = product\_definition\_relationship  
 {product\_definition\_relationship  
 (product\_definition\_relationship.name = 'support usage')  
 (product\_definition\_relationship.name = 'support usage connection')}  
 product\_definition\_relationship

**5.1.14.63.14 support\_constraints to support\_usage (positive rotation y-axis)**

AIM element: PATH

Reference path: support\_constraint\_representation <=  
 {representation  
 representation.items[i] ->  
 representation\_item  
 representation\_item.name = 'positive y rotation'}  
 representation <-  
 property\_definition\_representation.used\_representation  
 property\_definition\_representation  
 property\_definition\_representation.definition ->  
 represented\_definition  
 represented\_definition = property\_definition  
 property\_definition  
 property\_definition.definition ->  
 characterized\_definition  
 characterized\_definition = characterized\_product\_definition  
 characterized\_product\_definition  
 characterized\_product\_definition = product\_definition\_relationship  
 {product\_definition\_relationship  
 (product\_definition\_relationship.name = 'support usage')  
 (product\_definition\_relationship.name = 'support usage connection')}  
 product\_definition\_relationship

**5.1.14.63.15 support\_constraints to support\_usage (negative rotation z-axis)**

AIM element: PATH

Reference path: {representation  
 representation.items[i] ->  
 representation\_item  
 representation\_item.name = 'negative z rotation'}  
 representation <-  
 property\_definition\_representation.used\_representation  
 property\_definition\_representation  
 property\_definition\_representation.definition ->  
 represented\_definition  
 represented\_definition = property\_definition  
 property\_definition  
 property\_definition.definition ->  
 characterized\_definition  
 characterized\_definition = characterized\_product\_definition  
 characterized\_product\_definition  
 characterized\_product\_definition = product\_definition\_relationship  
 {product\_definition\_relationship  
 (product\_definition\_relationship.name = 'support usage')  
 (product\_definition\_relationship.name = 'support usage connection')}  
 product\_definition\_relationship

**5.1.14.63.16 support\_constraints to support\_usage (positive rotation z-axis)**

AIM element: PATH

Reference path: support\_constraint\_representation <=  
 {representation  
 representation.items[i] ->  
 representation\_item  
 representation\_item.name = 'positive z rotation'}  
 representation <-  
 property\_definition\_representation.used\_representation  
 property\_definition\_representation  
 property\_definition\_representation.definition ->  
 represented\_definition  
 represented\_definition = property\_definition  
 property\_definition  
 property\_definition.definition ->  
 characterized\_definition  
 characterized\_definition = characterized\_product\_definition  
 characterized\_product\_definition  
 characterized\_product\_definition = product\_definition\_relationship  
 {product\_definition\_relationship  
 (product\_definition\_relationship.name = 'support usage')  
 (product\_definition\_relationship.name = 'support usage connection')}  
 product\_definition\_relationship

**5.1.14.64 Support\_usage**

AIM element: product\_definition\_relationship

Source: 41

Reference path: {product\_definition\_relationship  
product\_definition\_relationship.name = 'support usage'}

**5.1.14.64.1 detail\_sheet\_reference**

AIM element: document

Source: 41

Reference path: product\_definition\_relationship  
document\_item = product\_definition\_relationship  
document\_item <-  
applied\_document\_reference.items[i]  
applied\_document\_reference <=  
document\_reference  
document\_reference.assigned\_document ->  
{document  
document.kind ->  
document\_type  
document\_type.product\_data\_type = 'drawing'}  
document

**5.1.14.64.2 function**

AIM element: product\_definition\_relationship.description

Source: 41

**5.1.14.65 Support\_usage\_connection**

AIM element: product\_definition\_relationship

Source: 41

Reference path: {product\_definition\_relationship  
product\_definition\_relationship.name = 'support usage connection'}

**5.1.14.65.1 support\_usage\_connection to plant\_item\_connection - occurrence**

AIM element: PATH

Rules: application\_context\_requires\_ap\_definition  
dependent\_instantiable\_application\_context  
dependent\_instantiable\_product\_definition\_context

product\_definition\_context\_name\_constraint  
 product\_definition\_usage\_constraint

Reference path: product\_definition\_relationship  
 [product\_definition\_relationship.relateing\_product\_definition ->]  
 [product\_definition\_relationship.related\_product\_definition ->]  
 {product\_definition  
 product\_definition.frame\_of\_reference ->  
 product\_definition\_context <=  
 application\_context\_element  
 (application\_context\_element.name = 'functional occurrence')  
 (application\_context\_element.name = 'physical occurrence')}  
 product\_definition  
 characterized\_product\_definition = product\_definition  
 characterized\_product\_definition  
 characterized\_definition = characterized\_product\_definition  
 characterized\_definition <=  
 property\_definition.definition  
 property\_definition =>  
 product\_definition\_shape <=  
 shape\_aspect.of\_shape  
 shape\_aspect =>  
 plant\_item\_connection

#### 5.1.14.66 System\_space

AIM element: system\_space

Source: 227

Rules: dependent\_instantiable\_product\_context  
 product\_context\_discipline\_type\_constraint  
 value\_for\_application\_context

Reference path: system\_space <=  
 product\_definition\_shape  
 {product\_definition\_shape <=  
 property\_definition  
 property\_definition.definition ->  
 characterized\_definition  
 characterized\_definition = characterized\_product\_definition  
 characterized\_product\_definition  
 characterized\_product\_definition = product\_definition  
 [product\_definition =>  
 (electrical\_system)  
 (ducting\_system)  
 (instrumentation\_and\_control\_system)  
 (piping\_system)  
 (structural\_system)  
 (cableway\_system)]  
 [product\_definition  
 product\_definition.formation ->  
 product\_definition\_formation  
 product\_definition\_formation.of\_product ->

```

product
product.frame_of_reference[i] ->
product_context<=
application_context_element
application_context_element.name = 'plant system']]

```

#### 5.1.14.67 Toothed\_lock\_washer

AIM element: bolt\_and\_nut\_component\_definition

Source: 227

Rules: dependent\_instantiable\_product\_context  
product\_context\_discipline\_type\_constraint  
value\_for\_application\_context

Reference path: bolt\_and\_nut\_component\_definition <=  
product\_definition  
{bolt\_and\_nut\_component\_definition  
classification\_item = piping\_support\_definition  
classification\_item <=  
applied\_classification\_assignment.items[i]  
applied\_classification\_assignment <=  
classification\_assignment  
classification\_assignment.assigned\_classification ->  
[group =>  
bolt\_and\_nut\_component\_class]  
[group  
group.name = 'toothed lock washer']  
[group <=  
group\_relationship.related\_group  
group\_relationship  
{group\_relationship.name = 'class hierarchy'}  
group\_relationship.relating\_group ->  
group  
{[group.name = 'washer']  
[group =>  
bolt\_and\_nut\_component\_class]}}  
{product\_definition  
product\_definition.formation ->  
product\_definition\_formation  
product\_definition\_formation.of\_product ->  
[product  
classification\_item = product  
classification\_item <=  
applied\_classification\_assignment.items[i]  
applied\_classification\_assignment <=  
classification\_assignment  
classification\_assignment.assigned\_classification ->  
(group)  
(group <=  
group\_relationship.related\_group  
group\_relationship  
group\_relationship.relating\_group ->

```

group)
group.name = 'bolt and nut component']
[product
product.frame_of_reference[i] ->
product_context <=
application_context_element
application_context_element.name = 'plant item']]

```

### 5.1.14.67.1 thickness

AIM element: [measure\_with\_unit.value\_component]  
[measure\_with\_unit.unit\_component]

Source: 41

Rules: subtype\_mandatory\_shape\_representation

Reference path: bolt\_and\_nut\_component\_definition <=  
product\_definition  
characterized\_product\_definition = product\_definition  
characterized\_product\_definition  
characterized\_definition = characterized\_product\_definition  
characterized\_definition <=  
property\_definition.definition  
property\_definition =>  
product\_definition\_shape <=  
shape\_aspect.of\_shape  
[shape\_aspect <=  
shape\_aspect\_relationship.relate\_shape\_aspect]  
[shape\_aspect <=  
shape\_aspect\_relationship.related\_shape\_aspect]  
shape\_aspect\_relationship =>  
dimensional\_location  
dimensional\_characteristic = dimensional\_location  
dimensional\_characteristic <=  
dimensional\_characteristic\_representation.dimension  
dimensional\_characteristic\_representation  
dimensional\_characteristic\_representation.representation ->  
shape\_dimension\_representation <=  
shape\_representation <=  
{representation  
representation.name = 'toothed lock washer dimensional shape'}  
representation  
representation.items[i] ->  
representation\_item =>  
{representation\_item.name = 'thickness'}  
measure\_representation\_item <=  
{measure\_with\_unit =>  
length\_measure\_with\_unit}  
measure\_with\_unit  
[measure\_with\_unit.value\_component]  
[measure\_with\_unit.unit\_component]

**5.1.14.67.2 outside\_diameter**

AIM element: [measure\_with\_unit.value\_component]  
[measure\_with\_unit.unit\_component]

Source: 41

Rules: subtype\_mandatory\_shape\_representation

Reference path: bolt\_and\_nut\_component\_definition <=  
product\_definition  
characterized\_product\_definition = product\_definition  
characterized\_product\_definition  
characterized\_definition = characterized\_product\_definition  
characterized\_definition <=  
property\_definition.definition  
property\_definition =>  
product\_definition\_shape <=  
shape\_aspect.of\_shape  
[shape\_aspect <=  
shape\_aspect\_relationship.relating\_shape\_aspect]  
[shape\_aspect <=  
shape\_aspect\_relationship.related\_shape\_aspect]  
shape\_aspect\_relationship =>  
dimensional\_location  
dimensional\_characteristic = dimensional\_location  
dimensional\_characteristic <=  
dimensional\_characteristic\_representation.dimension  
dimensional\_characteristic\_representation  
dimensional\_characteristic\_representation.representation ->  
shape\_dimension\_representation <=  
shape\_representation <=  
{representation  
representation.name = 'toothed lock washer dimensional shape'}  
representation  
representation.items[i] ->  
representation\_item =>  
{representation\_item.name = 'outside diameter'}  
measure\_representation\_item <=  
{measure\_with\_unit =>  
length\_measure\_with\_unit}  
measure\_with\_unit  
[measure\_with\_unit.value\_component]  
[measure\_with\_unit.unit\_component]

**5.1.14.68 Trunnion**

AIM element: piping\_support\_definition

Source: 227

Rules: dependent\_instantiable\_product\_context  
product\_context\_discipline\_type\_constraint  
value\_for\_application\_context

Reference path: `piping_support_definition <=`  
`product_definition`  
`{piping_support_definition`  
`classification_item = piping_support_definition`  
`classification_item <-`  
`applied_classification_assignment.items[i]`  
`applied_classification_assignment <=`  
`classification_assignment`  
`classification_assignment.assigned_classification ->`  
`[group =>`  
`piping_support_fitting_-class]`  
`[group`  
`group.name = 'trunnion']}`  
`{product_definition`  
`product_definition.formation ->`  
`product_definition_formation`  
`product_definition_formation.of_product ->`  
`[product`  
`classification_item = product`  
`classification_item <-`  
`applied_classification_assignment.items[i]`  
`applied_classification_assignment <=`  
`classification_assignment`  
`classification_assignment.assigned_classification ->`  
`(group)`  
`(group <-`  
`group_relationship.related_group`  
`group_relationship`  
`group_relationship.relating_group ->`  
`group)`  
`group.name = 'piping support']`  
`[product`  
`product.frame_of_reference[i] ->`  
`product_context <=`  
`application_context_element`  
`application_context_element.name = 'plant item']})`

### 5.1.14.68.1 length

AIM element: `[measure_with_unit.value_component]`  
`[measure_with_unit.unit_component]`

Source: 41

Rules: `subtype_mandatory_shape_representation`

Reference path: `piping_support_definition <=`  
`product_definition`  
`characterized_product_definition = product_definition`  
`characterized_product_definition`  
`characterized_definition = characterized_product_definition`  
`characterized_definition <-`  
`property_definition.definition`

```

property_definition =>
product_definition_shape <-
shape_aspect.of_shape
[shape_aspect <-
shape_aspect_relationship.relating_shape_aspect]
[shape_aspect <-
shape_aspect_relationship.related_shape_aspect]
shape_aspect_relationship =>
dimensional_location
dimensional_characteristic = dimensional_location
dimensional_characteristic <-
dimensional_characteristic_representation.dimension
dimensional_characteristic_representation
dimensional_characteristic_representation.representation ->
shape_dimension_representation <=
shape_representation <=
{representation
representation.name = 'trunnion dimensional shape'}
representation
representation.items[i] ->
representation_item =>
{representation_item.name = 'length'}
measure_representation_item <=
{measure_with_unit =>
length_measure_with_unit}
measure_with_unit
[measure_with_unit.value_component]
[measure_with_unit.unit_component]

```

#### 5.1.14.69 User\_defined\_attribute\_value

AIM element: (measure\_representation\_item)

(descriptive\_representation\_item)

Source: 45

Reference path: {(measure\_representation\_item <=)  
(descriptive\_representation\_item <=)  
representation\_item <-  
representation.items[i]  
representation  
representation.name = 'user defined attributes'}

##### 5.1.14.69.1 name

AIM element: representation\_item.name

Source: 43

Reference path: (measure\_representation\_item <=)  
(descriptive\_representation\_item <=)  
representation\_item

representation\_item.name

### 5.1.14.69.2 value

AIM element: ([measure\_with\_unit.value\_component]  
[measure\_with\_unit.unit\_component])

(descriptive\_representation\_item.description)

Source: 41

Reference path: (measure\_representation\_item <=  
measure\_with\_unit  
[measure\_with\_unit.value\_component]  
[measure\_with\_unit.unit\_component])

(descriptive\_representation\_item  
descriptive\_representation\_item.description)

45

### 5.1.14.69.3 user\_defined\_attribute\_value to plant\_item

AIM element: PATH

Reference path: (measure\_representation\_item <=)  
(descriptive\_representation\_item <=)  
representation\_item <-  
representation.items[i]  
representation <-  
property\_definition\_representation.used\_representation  
property\_definition\_representation  
property\_definition\_representation.definition ->  
represented\_definition  
represented\_definition = property\_definition  
property\_definition  
property\_definition.definition ->  
characterized\_definition  
characterized\_definition = characterized\_product\_definition  
characterized\_product\_definition  
characterized\_product\_definition = product\_definition  
(product\_definition)  
(product\_definition =>  
externally\_defined\_plant\_item\_definition)  
(product\_definition  
product\_definition.formation ->  
product\_definition\_formation  
product\_definition\_formation.of\_product ->  
product)

### 5.1.14.70 Washer

AIM element: bolt\_and\_nut\_component\_definition

Source: 227

Rules: dependent\_instantiable\_product\_context  
product\_context\_discipline\_type\_constraint  
value\_for\_application\_context

Reference path: bolt\_and\_nut\_component\_definition <=  
product\_definition  
{bolt\_and\_nut\_component\_definition  
classification\_item = piping\_support\_definition  
classification\_item <=  
applied\_classification\_assignment.items[i]  
applied\_classification\_assignment <=  
classification\_assignment  
classification\_assignment.assigned\_classification ->  
[group =>  
bolt\_and\_nut\_component\_class]  
[group  
group.name = 'washer']}  
{product\_definition  
product\_definition.formation ->  
product\_definition\_formation  
product\_definition\_formation.of\_product ->  
[product  
classification\_item = product  
classification\_item <=  
applied\_classification\_assignment.items[i]  
applied\_classification\_assignment <=  
classification\_assignment  
classification\_assignment.assigned\_classification ->  
(group)  
(group <=  
group\_relationship.related\_group  
group\_relationship  
group\_relationship.relying\_group ->  
group)  
group.name = 'bolt and nut component']  
[product  
product.frame\_of\_reference[i] ->  
product\_context <=  
application\_context\_element  
application\_context\_element.name = 'plant item']]}

#### 5.1.14.70.1 washer\_type

AIM element: group.name

Source: 41

Reference path: bolt\_and\_nut\_component\_definition  
classification\_item = piping\_support\_definition  
classification\_item <=

```

applied_classification_assignment.items[i]
applied_classification_assignment <=
classification_assignment
classification_assignment.assigned_classification ->
group <-
{[group =>
bolt_and_nut_component_class]
[group
group.name = 'washer']}
group_relationship.relatng_group
group_relationship
{group_relationship.name = 'class hierarchy'}
group_relationship.related_group ->
group
{group =>
bolt_and_nut_component_class}
group.name

```

### 5.1.15 Shape UoF

#### 5.1.15.1 Detail\_shape

AIM element: representation.name

Source: 43

Reference path: {representation.name = 'detail'}

#### 5.1.15.2 Envelope\_shape

AIM element: representation.name

Source: 43

Reference path: {representation.name = 'envelope'}

#### 5.1.15.3 Hybrid\_shape\_representation

AIM element: hybrid\_shape\_representation

Source: 227

Reference path: hybrid\_shape\_representation <=
shape\_representation

#### 5.1.15.4 Interfering\_shape\_element

AIM element: interfering\_shape\_element

Source: 227

Reference path: interfering\_shape\_element <=  
[shape\_aspect\_relationship]  
[shape\_aspect]

#### **5.1.15.4.1 interference\_colour**

AIM element: descriptive\_colour

Source: 227

Reference path: interfering\_shape\_element <=  
shape\_aspect  
shape\_definition = shape\_aspect  
shape\_definition  
characterized\_definition = shape\_definition  
characterized\_definition <=  
property\_definition.definition  
property\_definition  
represented\_definition = property\_definition  
represented\_definition <=  
property\_definition\_representation.definition  
property\_definition\_representation  
property\_definition\_representation.used\_representation ->  
representation  
representation.items[i] ->  
{representation\_item  
representation\_item.name = 'interference colour'}  
representation\_item =>  
descriptive\_representation\_item =>  
{descriptive\_colour <=  
colour}  
descriptive\_colour

#### **5.1.15.5 Outline\_shape**

AIM element: representation.name

Source: 43

Reference path: {representation.name = 'outline'}

#### **5.1.15.6 Plant\_csg\_shape\_representation**

AIM element: plant\_csg\_shape\_representation

Source: 227

Reference path: plant\_csg\_shape\_representation <=  
shape\_representation

#### **5.1.15.7 Plant\_item\_centreline**

AIM element: centre\_of\_symmetry

Source: 47

### 5.1.15.8 Plant\_item\_interference

AIM element: plant\_item\_interference

Source: 227

Reference path: plant\_item\_interference <=  
product\_definition\_relationship

#### 5.1.15.8.1 interference\_id

AIM element: product\_definition\_relationship.name

Source: 41

Reference path: plant\_item\_interference <=  
product\_definition\_relationship  
product\_definition\_relationship.name

#### 5.1.15.8.2 type

AIM element: product\_definition\_relationship.description

Source: 41

Reference path: plant\_item\_interference <=  
product\_definition\_relationship  
product\_definition\_relationship.description

#### 5.1.15.8.3 plant\_item\_interference to interfering\_shape\_element

AIM element: PATH

Reference path: plant\_item\_interference <=  
product\_definition\_relationship  
product\_definition\_relationship.relateing\_product\_definition ->  
product\_definition  
characterized\_product\_definition = product\_definition  
characterized\_product\_definition  
characterized\_definition = characterized\_product\_definition  
characterized\_definition <=  
property\_definition.definition  
property\_definition =>  
product\_definition\_shape <=  
shape\_aspect.of\_shape  
shape\_aspect =>  
interfering\_shape\_element

**5.1.15.8.4 plant\_item\_interference to plant\_item\_interference\_status**

AIM element: PATH

Reference path: plant\_item\_interference <=  
product\_definition\_relationship  
(plant\_spatial\_configuration\_organization\_item = product\_definition\_relationship  
plant\_spatial\_configuration\_organization\_item <=  
plant\_spatial\_configuration\_organization\_assignment.items[i]  
plant\_spatial\_configuration\_organization\_assignment)  
(plant\_spatial\_configuration\_person\_item = product\_definition\_relationship  
plant\_spatial\_configuration\_person\_item <=  
plant\_spatial\_configuration\_person\_assignment.items[i]  
plant\_spatial\_configuration\_person\_assignment)  
(characterized\_product\_definition = product\_definition\_relationship  
characterized\_product\_definition  
characterized\_definition = characterized\_product\_definition  
characterized\_definition <=  
property\_definition.definition  
property\_definition  
represented\_definition = property\_definition  
represented\_definition <=  
property\_definition\_representation.definition  
property\_definition\_representation  
property\_definition\_representation.used\_representation ->  
representation)

**5.1.15.8.5 plant\_item\_interference to shape\_interference\_zone\_usage**

AIM element: PATH

Rules: subtype\_mandatory\_shape\_representation

Reference path: plant\_item\_interference <=  
product\_definition\_relationship  
characterized\_product\_definition = product\_definition\_relationship  
characterized\_product\_definition  
characterized\_definition = characterized\_product\_definition  
characterized\_definition <=  
property\_definition.definition  
property\_definition  
represented\_definition = property\_definition  
represented\_definition <=  
property\_definition\_representation.definition  
property\_definition\_representation  
property\_definition\_representation.used\_representation ->  
{representation =>  
shape\_representation}  
representation  
representation.items[i] ->  
representation\_item =>  
mapped\_item

### 5.1.15.9 Plant\_item\_interference\_status

AIM element: representation

Source: 43

Reference path: {representation  
representation.name = 'plant item interference status'}

#### 5.1.15.9.1 assessor

AIM element: (organization.name)  
([person.first\_name]  
[person.last\_name])

Source: 41

Reference path: (representation  
plant\_spatial\_configuration\_organization\_item = representation  
plant\_spatial\_configuration\_organization\_item <-  
plant\_spatial\_configuration\_organization\_assignment.items [i]  
plant\_spatial\_configuration\_organization\_assignment <=  
organization\_assignment  
organization\_assignment.assigned\_organization ->  
organization  
organization.name)  
(representation  
plant\_spatial\_configuration\_person\_item = representation  
plant\_spatial\_configuration\_person\_item <-  
plant\_spatial\_configuration\_person\_assignment.items [i]  
plant\_spatial\_configuration\_person\_assignment <=  
person\_assignment  
person\_assignment.assigned\_person ->  
person  
[person.first\_name]  
[person.last\_name])

#### 5.1.15.9.2 status

AIM element: descriptive\_representation\_item.description

Source: 45

Reference path: representation  
representation.items[i] ->  
{representation\_item  
representation\_item.name = 'interference status'}  
representation\_item =>  
descriptive\_representation\_item  
descriptive\_representation\_item.description

**5.1.15.10 Plant\_item\_shape**

AIM element: product\_definition\_shape

Source: 41

Reference path: {product\_definition\_shape <=  
property\_definition  
property\_definition.definition ->  
characterized\_definition  
characterized\_definition = characterized\_product\_definition  
characterized\_product\_definition  
characterized\_product\_definition = product\_definition  
product\_definition  
product\_definition.frame\_of\_reference ->  
product\_definition\_context <=  
application\_context\_element  
(application\_context\_element.name = 'physical definition')  
(application\_context\_element.name = 'physical occurrence')}

**5.1.15.10.1 clash\_detection\_class**

AIM element: property\_definition.description

Source: 41

Reference path: product\_definition\_shape <=  
property\_definition  
property\_definition.description  
{(property\_definition.description = 'hard')  
(property\_definition.description = 'ignore')  
(property\_definition.description = 'soft')}

**5.1.15.10.2 origin**

AIM element: (axis2\_placement\_2d)  
(axis2\_placement\_3d)

Source: 42

Reference path: product\_definition\_shape <=  
property\_definition  
represented\_definition = property\_definition  
represented\_definition <-  
property\_definition\_representation.definition  
property\_definition\_representation  
property\_definition\_representation.used\_representation ->  
representation  
representation.items[i] ->  
{representation\_item  
representation\_item.name = 'plant item orientation'}  
representation\_item =>  
geometric\_representation\_item =>

```

{placement
placement.location ->
cartesian_point <=
point <=
geometric_representation_item <=
representation_item
representation_item.name = 'plant item location'}
placement =>
(axis2_placement_2d)
(axis2_placement_3d)

```

### 5.1.15.10.3 shape\_id

AIM element: property\_definition.name

Source: 41

Reference path: product\_definition\_shape <=
property\_definition
property\_definition.name

### 5.1.15.10.4 plant\_item\_shape to changed\_plant\_item\_shape

AIM element: IDENTICAL MAPPING

### 5.1.15.10.5 plant\_item\_shape to shape\_representation

AIM element: PATH

Reference path: product\_definition\_shape <=
property\_definition
represented\_definition = property\_definition
represented\_definition <-
property\_definition\_representation.definition
property\_definition\_representation
{property\_definition\_representation =>
shape\_definition\_representation}
property\_definition\_representation.used\_representation ->
representation =>
shape\_representation =>
(plant\_csg\_shape\_representation)
(hybrid\_shape\_representation)

### 5.1.15.11 Reference\_geometry

AIM element: reference\_geometry

Source: 227

Reference path: reference\_geometry <=
derived\_shape\_aspect

**5.1.15.11.1 name**

AIM element: shape\_aspect.name

Source: 41

Reference path: reference\_geometry <=  
derived\_shape\_aspect <=  
shape\_aspect  
shape\_aspect.name

**5.1.15.11.2 reference\_geometry\_id**

AIM element: representation\_item.name

Source: 43

Reference path: reference\_geometry <=  
derived\_shape\_aspect <=  
shape\_aspect  
shape\_definition = shape\_aspect  
shape\_definition  
characterized\_definition = shape\_definition  
characterized\_definition <=  
property\_definition.definition  
property\_definition  
represented\_definition = property\_definition  
represented\_definition <=  
property\_definition\_representation.definition  
property\_definition\_representation  
property\_definition\_representation.used\_representation ->  
representation  
representation.items[i] ->  
representation\_item  
representation\_item.name

**5.1.15.11.3 reference\_geometry to changed\_reference\_geometry**

AIM element: IDENTICAL MAPPING

**5.1.15.11.4 reference\_geometry to shape\_representation\_element**

AIM element: PATH

Reference path: reference\_geometry <=  
derived\_shape\_aspect <=  
shape\_aspect  
shape\_definition = shape\_aspect  
shape\_definition  
characterized\_definition = shape\_definition  
characterized\_definition <=  
property\_definition.definition  
property\_definition

```

represented_definition = property_definition
represented_definition <-
property_definition_representation.definition
property_definition_representation
property_definition_representation.used_representation ->
representation
representation.items[i] ->
representation_item

```

#### 5.1.15.12 Shape\_interference\_zone\_usage

AIM element: mapped\_item

Source: 43

#### 5.1.15.13 Shape\_parameter

AIM element: measure\_representation\_item

Source: 45

Reference path: {measure\_representation\_item <=  
representation\_item <=  
representation.items[i]  
representation =>  
shape\_representation =>  
hybrid\_shape\_representation}

##### 5.1.15.13.1 name

AIM element: representation\_item.name

Source: 43

Reference path: measure\_representation\_item <=  
representation\_item  
representation\_item.name

##### 5.1.15.13.2 value

AIM element: [measure\_with\_unit.value\_component]  
[measure\_with\_unit.unit\_component]

Source: 41

Reference path: measure\_representation\_item <=  
measure\_with\_unit  
[measure\_with\_unit.value\_component]  
[measure\_with\_unit.unit\_component]

**5.1.15.14 Shape\_representation**

AIM element: (hybrid\_shape\_representation)  
(plant\_csg\_shape\_representation)

Source: 227

Reference path: (hybrid\_shape\_representation <=)  
(plant\_csg\_shape\_representation <=)  
shape\_representation  
{ shape\_representation <=  
representation  
(representation.name = 'detail')  
(representation.name = 'envelope')  
(representation.name = 'outline')}

**5.1.15.14.1 shape\_representation to shape\_representation\_element\_usage**

AIM element: PATH

Rules: subtype\_mandatory\_shape\_representation

Reference path: property\_definition\_representation  
property\_definition\_representation.used\_representation ->  
{ representation =>  
shape\_representation =>  
(plant\_csg\_shape\_representation)  
(hybrid\_shape\_representation)}  
representation  
representation.items[i] ->  
representation\_item

**5.1.15.15 Shape\_representation\_element**

AIM element: representation\_item

Source: 43

**5.1.15.15.1 element\_id**

AIM element: representation\_item.name

Source: 43

**5.1.15.15.2 shape\_representation\_element to shape\_interference\_zone\_usage**

AIM element: PATH

Reference path: representation\_item <-  
representation\_map.mapping\_origin  
representation\_map <-

mapped\_item.mapping\_source  
mapped\_item

### **5.1.15.15.3 shape\_representation\_element to shape\_representation\_element\_usage**

AIM element: IDENTICAL MAPPING

Rules: subtype\_mandatory\_shape\_representation

### **5.1.15.16 Shape\_representation\_element\_usage**

AIM element: representation\_item

Source: 43

#### **5.1.15.16.1 element\_colour**

AIM element: descriptive\_colour

Source: 227

Rules: subtype\_mandatory\_shape\_representation

Reference path: representation\_item <-  
representation\_item\_relationship.related\_representation\_item  
{representation\_item\_relationship  
representation\_item\_relationship.name = 'element color association'}  
representation\_item\_relationship  
representation\_item\_relationship.relateing\_representation\_item ->  
{representation\_item  
representation\_item.name = 'element colour'}  
representation\_item =>  
descriptive\_representation\_item =>  
{descriptive\_colour <=  
colour}  
descriptive\_colour

#### **5.1.15.16.2 layer**

AIM element: presentation\_layer\_assignment

Source: 46

Rules: subtype\_mandatory\_shape\_representation

Reference path: representation\_item  
layered\_item = representation\_item  
layered\_item <-  
presentation\_layer\_assignment.assigned\_items[i]  
presentation\_layer\_assignment

### 5.1.15.16.3 **shape\_representation\_element\_usage to interfering\_shape\_element**

AIM element: PATH

Rules: subtype\_mandatory\_shape\_representation

Reference path: representation\_item <-  
 item\_identified\_representation\_usage.identified\_item  
 item\_identified\_representation\_usage  
 item\_identified\_representation\_usage.definition ->  
 represented\_definition  
 represented\_definition = shape\_aspect  
 shape\_aspect =>  
 interfering\_shape\_element

## 5.1.16 Site\_characterization UoF

### 5.1.16.1 Breakline

AIM element: polyline

Source: 42

#### 5.1.16.1.1 breakline to survey\_point

AIM element: PATH

Reference path: polyline  
 polyline.points[i] ->  
 cartesian\_point  
 {cartesian\_point <=  
 point <=  
 geometric\_representation\_item <=  
 representation\_item  
 representation\_item.name = 'survey point'}

### 5.1.16.2 Building

AIM element: site\_building

Source: 227

Reference path: site\_building <=  
 property\_definition

#### 5.1.16.2.1 building\_id

AIM element: representation

Source: 43

Reference path: site\_building <=  
property\_definition  
represented\_definition = property\_definition  
represented\_definition <=  
property\_definition\_representation.definition  
property\_definition\_representation  
property\_definition\_representation.used\_representation ->  
representation  
{representation  
[representation.name = 'building number']  
[representation.items[i] ->  
representation\_item =>  
descriptive\_representation\_item]]}

### 5.1.16.2.2 location\_and\_orientation

AIM element: [(axis2\_placement\_2d)  
(axis2\_placement\_3d)]  
[cartesian\_point]

Source: 42

Reference path: site\_building <=  
property\_definition  
represented\_definition = property\_definition  
represented\_definition <=  
property\_definition\_representation.definition  
property\_definition\_representation  
property\_definition\_representation.used\_representation ->  
representation  
representation.items[i] ->  
{representation\_item  
representation\_item.name = 'building orientation'}  
representation\_item =>  
geometric\_representation\_item =>  
[placement =>  
(axis2\_placement\_2d)  
(axis2\_placement\_3d)]  
[placement  
placement.location ->  
cartesian\_point  
{cartesian\_point <=  
point <=  
geometric\_representation\_item <=  
representation\_item  
representation\_item.name = 'building location'}}]

### 5.1.16.2.3 name

AIM element: property\_definition.name

Source: 41

Reference path: site\_building <=  
property\_definition  
property\_definition.name

#### 5.1.16.2.4 shape

AIM element: shape\_representation

Source: 41

Rules: subtype\_mandatory\_shape\_representation

Reference path: site\_building <=  
{property\_definition =>  
product\_definition\_shape}  
property\_definition  
represented\_definition = property\_definition  
represented\_definition <=  
property\_definition\_representation.definition  
{property\_definition\_representation =>  
shape\_definition\_representation}  
property\_definition\_representation  
property\_definition\_representation.used\_representation ->  
representation =>  
shape\_representation

#### 5.1.16.2.5 building to location\_in\_building

AIM element: PATH

Reference path: site\_building <=  
property\_definition  
represented\_definition = property\_definition  
represented\_definition <=  
property\_definition\_representation.definition  
property\_definition\_representation  
property\_definition\_representation.used\_representation ->  
representation  
representation.items[i] ->  
representation\_item =>  
geometric\_representation\_item =>  
placement =>  
(axis2\_placement\_2d)  
(axis2\_placement\_3d)

#### 5.1.16.2.6 building to reference\_geometry

AIM element: PATH

Reference path: site\_building <=  
property\_definition =>

```

product_definition_shape <-
shape_aspect.of_shape
shape_aspect =>
derived_shape_aspect =>
reference_geometry

```

### 5.1.16.3 Facet\_trigon

AIM element: poly\_loop

Source: 42

#### 5.1.16.3.1 facet\_trigon to survey\_point

AIM element: PATH

Reference path: poly\_loop  
poly\_loop.polygon[i] ->  
cartesian\_point  
{ cartesian\_point <=  
point <=  
geometric\_representation\_item <=  
representation\_item  
representation\_item.name = 'survey point' }

### 5.1.16.4 Faceted\_surface\_representation

AIM element: site\_representation

Source: 227

Rules: subtype\_mandatory\_shape\_representation

Reference path: site\_representation <=  
shape\_representation  
{ shape\_representation <=  
representation  
representation.items[i] ->  
representation\_item =>  
topological\_representation\_item =>  
connected\_face\_set }

#### 5.1.16.4.1 faceted\_surface\_representation to facet\_trigon

AIM element: PATH

Rules: subtype\_mandatory\_shape\_representation

Reference path: site\_representation <=  
shape\_representation <=  
representation  
representation.items[i] ->

```

representation_item =>
topological_representation_item =>
connected_face_set
connected_face_set.cfs_faces[i] ->
{ face =>
face_surface}
face
face.bounds[i] ->
face_bound
face_bound.bound ->
loop =>
poly_loop

```

### 5.1.16.5 Gis\_position

AIM element: representation

Source: 43

Reference path: {representation  
representation.name = 'gis position'}

#### 5.1.16.5.1 height

AIM element: [measure\_with\_unit.value\_component]  
[measure\_with\_unit.unit\_component]

Source: 41

Reference path: representation  
representation.items[i] ->  
{representation\_item  
representation\_item.name = 'height'}  
representation\_item =>  
measure\_representation\_item <=  
measure\_with\_unit  
[measure\_with\_unit.value\_component]  
[measure\_with\_unit.unit\_component]

#### 5.1.16.5.2 scale

AIM element: [measure\_with\_unit.value\_component]  
[measure\_with\_unit.unit\_component]

Source: 41

Reference path: representation  
representation.items[i] ->  
{representation\_item  
representation\_item.name = 'scale'}  
representation\_item =>  
measure\_representation\_item <=  
measure\_with\_unit

[measure\_with\_unit.value\_component]  
[measure\_with\_unit.unit\_component]

### 5.1.16.5.3 system

AIM element: representation\_context.context\_type

Source: 43

Reference path: representation  
representation.context\_of\_items ->  
representation\_context  
representation\_context.context\_type

### 5.1.16.5.4 x\_axis\_delta\_x

AIM element: [measure\_with\_unit.value\_component]  
[measure\_with\_unit.unit\_component]

Source: 41

Reference path: representation  
representation.items[i] ->  
{representation\_item  
representation\_item.name = 'x-axis delta x'}  
representation\_item =>  
measure\_representation\_item <=  
measure\_with\_unit  
[measure\_with\_unit.value\_component]  
[measure\_with\_unit.unit\_component]

### 5.1.16.5.5 x\_axis\_delta\_y

AIM element: [measure\_with\_unit.value\_component]  
[measure\_with\_unit.unit\_component]

Source: 41

Reference path: representation  
representation.items[i] ->  
{representation\_item  
representation\_item.name = 'x-axis delta y'}  
representation\_item =>  
measure\_representation\_item <=  
measure\_with\_unit  
[measure\_with\_unit.value\_component]  
[measure\_with\_unit.unit\_component]

### 5.1.16.5.6 x\_coordinate

AIM element: [measure\_with\_unit.value\_component]

[measure\_with\_unit.unit\_component]

Source: 41

Reference path: representation  
 representation.items[i] ->  
 {representation\_item  
 representation\_item.name = 'x coordinate'}  
 representation\_item =>  
 measure\_representation\_item <=  
 measure\_with\_unit  
 [measure\_with\_unit.value\_component]  
 [measure\_with\_unit.unit\_component]

#### 5.1.16.5.7 y\_coordinate

AIM element: [measure\_with\_unit.value\_component]  
 [measure\_with\_unit.unit\_component]

Source: 41

Reference path: representation  
 representation.items[i] ->  
 {representation\_item  
 representation\_item.name = 'y coordinate'}  
 representation\_item =>  
 measure\_representation\_item <=  
 measure\_with\_unit  
 [measure\_with\_unit.value\_component]  
 [measure\_with\_unit.unit\_component]

#### 5.1.16.5.8 zone

AIM element: descriptive\_representation\_item.description

Source: 45

Reference path: representation  
 representation.items[i] ->  
 {representation\_item  
 representation\_item.name = 'zone'}  
 representation\_item =>  
 descriptive\_representation\_item  
 descriptive\_representation\_item.description

#### 5.1.16.6 Location\_in\_building

AIM element: (axis2\_placement\_2d)  
 (axis2\_placement\_3d)

Source: 42

Reference path: {(axis2\_placement\_2d <=)  
 (axis2\_placement\_3d <=)  
 placement <=  
 geometric\_representation\_item <=  
 representation\_item <=  
 representation.items[i]  
 representation <=  
 property\_definition\_representation.used\_representation  
 property\_definition\_representation  
 property\_definition\_representation.definition ->  
 represented\_definition  
 represented\_definition = property\_definition  
 property\_definition =>  
 site\_building}

### 5.1.16.7 Location\_in\_site

AIM element: (axis2\_placement\_2d)  
 (axis2\_placement\_3d)

Source: 42

Reference path: {(axis2\_placement\_2d <=)  
 (axis2\_placement\_3d <=)  
 placement <=  
 geometric\_representation\_item <=  
 representation\_item <=  
 representation.items[i]  
 representation <=  
 property\_definition\_representation.used\_representation  
 {property\_definition\_representation =>  
 shape\_definition\_representation}  
 property\_definition\_representation  
 property\_definition\_representation.definition ->  
 represented\_definition  
 represented\_definition = property\_definition  
 {property\_definition =>  
 product\_definition\_shape}  
 property\_definition  
 property\_definition.definition ->  
 characterized\_definition  
 characterized\_definition = characterized\_object  
 characterized\_object =>  
 site}

### 5.1.16.8 Point\_and\_line\_representation

AIM element: site\_representation

Source: 227

Reference path: site\_representation <=  
 shape\_representation

```

{shape_representation <=
representation
representation.items[i] ->
representation_item =>
geometric_representation_item =>
geometric_set =>
geometric_curve_set}

```

### 5.1.16.8.1 point\_and\_line\_representation to survey\_point

AIM element: PATH

Rules: subtype\_mandatory\_shape\_representation

Reference path:

```

site_representation <=
shape_representation <=
representation
representation.items[i] ->
representation_item =>
geometric_representation_item =>
{geometric_set =>
geometric_curve_set}
geometric_set
geometric_set.elements[i] ->
geometric_set_select
geometric_set_select = point
point =>
cartesian_point
{cartesian_point <=
point <=
geometric_representation_item <=
representation_item
representation_item.name = 'survey point'}

```

### 5.1.16.9 Site

AIM element: site

Source: 227

Reference path:

```

site <=
[characterized_object]
[property_definition]

```

#### 5.1.16.9.1 address

AIM element: representation

Source: 43

Rules: subtype\_exclusive\_characterized\_object

Reference path: site <=  
 characterized\_object  
 characterized\_definition = characterized\_object  
 characterized\_definition <=  
 property\_definition.definition  
 property\_definition  
 represented\_definition = property\_definition  
 represented\_definition <=  
 property\_definition\_representation.definition  
 property\_definition\_representation  
 property\_definition\_representation.used\_representation ->  
 representation  
 {representation  
 representation.name = 'site address'}

### 5.1.16.9.2 coordinates

AIM element: representation

Source: 43

Rules: subtype\_exclusive\_characterized\_object

Reference path: site <=  
 characterized\_object  
 characterized\_definition = characterized\_object  
 characterized\_definition <=  
 property\_definition.definition  
 property\_definition  
 represented\_definition = property\_definition  
 represented\_definition <=  
 property\_definition\_representation.definition  
 property\_definition\_representation  
 property\_definition\_representation.used\_representation ->  
 representation  
 {representation  
 representation.name = 'site coordinates'}

### 5.1.16.9.3 elevation

AIM element: representation

Source: 43

Rules: subtype\_exclusive\_characterized\_object

Reference path: site <=  
 characterized\_object  
 characterized\_definition = characterized\_object  
 characterized\_definition <=  
 property\_definition.definition  
 property\_definition  
 represented\_definition = property\_definition

```

represented_definition <-
property_definition_representation.definition
property_definition_representation
property_definition_representation.used_representation ->
representation
{representation
representation.name = 'site elevation'}
```

#### 5.1.16.9.4 environmental\_references

AIM element: document.id

Source: 41

Reference path: site  
document\_item = site  
document\_item <-  
applied\_document\_reference.items[i]  
applied\_document\_reference <=  
document\_reference  
document\_reference.assigned\_document ->  
document  
document.id

#### 5.1.16.9.5 locality

AIM element: representation

Source: 43

Rules: subtype\_exclusive\_characterized\_object

Reference path: site <=  
characterized\_object  
characterized\_definition = characterized\_object  
characterized\_definition <-  
property\_definition.definition  
property\_definition  
represented\_definition = property\_definition  
represented\_definition <-  
property\_definition\_representation.definition  
property\_definition\_representation  
property\_definition\_representation.used\_representation ->  
representation  
{representation  
representation.name = 'site locality'}

#### 5.1.16.9.6 name

AIM element: characterized\_object.description

Source: 41

Rules: subtype\_exclusive\_characterized\_object

Reference path: site <=  
characterized\_object  
characterized\_object.description

### 5.1.16.9.7 orientation

AIM element: (axis2\_placement\_2d)  
(axis2\_placement\_3d)

Source: 42

Rules: subtype\_exclusive\_characterized\_object

Reference path: site <=  
characterized\_object  
characterized\_definition = characterized\_object  
characterized\_definition <=  
property\_definition.definition  
property\_definition  
represented\_definition = property\_definition  
represented\_definition <=  
property\_definition\_representation.definition  
property\_definition\_representation  
property\_definition\_representation.used\_representation ->  
representation  
representation.items[i] ->  
{representation\_item  
representation\_item.name = 'site orientation'}  
representation\_item =>  
geometric\_representation\_item =>  
{placement  
placement.location ->  
cartesian\_point <=  
point <=  
geometric\_representation\_item <=  
representation\_item  
representation\_item.name = 'site location'}  
placement =>  
(axis2\_placement\_2d)  
(axis2\_placement\_3d)

### 5.1.16.9.8 owners

AIM element: (person)  
(organization)  
(person\_and\_organization)

Source: 41

Reference path: site  
(plant\_spatial\_configuration\_person\_item = site

```

plant_spatial_configuration_person_item <-
plant_spatial_configuration_person_assignment.items[i]
plant_spatial_configuration_person_assignment <=
{person_assignment
person_assignment.role ->
person_role
person_role.name = 'owner'}
person_assignment
person_assignment.assigned_person ->
person)
(plant_spatial_configuration_organization_item = site
plant_spatial_configuration_organization_item <-
plant_spatial_configuration_organization_assignment.items[i]
plant_spatial_configuration_organization_assignment <=
{organization_assignment
organization_assignment.role ->
organization_role
organization_role.name = 'owner'}
organization_assignment
organization_assignment.assigned_organization ->
organization)
(plant_spatial_configuration_person_and_organization_item = site
plant_spatial_configuration_person_and_organization_item <-
plant_spatial_configuration_person_and_organization_assignment.items[i]
plant_spatial_configuration_person_and_organization_assignment <=
{person_and_organization_assignment
person_and_organization_assignment.role ->
person_and_organization_role
person_and_organization_role.name = 'owner'}
person_and_organization_assignment
person_and_organization_assignment.assigned_person_and_organization ->
person_and_organization)

```

#### 5.1.16.9.9 site\_id

AIM element: characterized\_object.name

Source: 41

Rules: subtype\_exclusive\_characterized\_object

Reference path: site <=  
characterized\_object  
characterized\_object.name

#### 5.1.16.9.10 site to building

AIM element: PATH

Rules: subtype\_exclusive\_characterized\_object

Reference path: site <=  
characterized\_object

```

characterized_definition = characterized_object
characterized_definition <-
property_definition.definition
property_definition =>
site_building

```

#### **5.1.16.9.11 site to changed\_site**

AIM element: IDENTICAL MAPPING

#### **5.1.16.9.12 site to location\_in\_site**

AIM element: PATH

Rules: subtype\_exclusive\_characterized\_object

Reference path:

```

site <=
characterized_object
characterized_definition = characterized_object
characterized_definition <-
property_definition.definition
property_definition
represented_definition = property_definition
represented_definition <-
property_definition_representation.definition
property_definition_representation
property_definition_representation.used_representation ->
representation
representation.items[i] ->
representation_item =>
geometric_representation_item =>
placement =>
(axis2_placement_2d)
(axis2_placement_3d)

```

#### **5.1.16.9.13 site to site\_feature**

AIM element: PATH

Rules: subtype\_exclusive\_characterized\_object

Reference path:

```

site <=
characterized_object
characterized_definition = characterized_object
characterized_definition <-
property_definition.definition
property_definition =>
site_feature

```

#### **5.1.16.9.14 site to site\_shape\_representation**

AIM element: PATH

Rules: subtype\_exclusive\_characterized\_object  
subtype\_mandatory\_shape\_representation

Reference path: site <=  
characterized\_object  
characterized\_definition = characterized\_object  
characterized\_definition <=  
property\_definition.definition  
{property\_definition =>  
product\_definition\_shape}  
property\_definition  
property\_definition.used\_representation ->  
representation =>  
shape\_representation =>  
site\_representation

#### 5.1.16.9.15 site to sited\_plant

AIM element: PATH

Reference path: site <=  
property\_definition <=  
property\_definition\_relationship.relating\_property\_definition  
{property\_definition\_relationship  
property\_definition\_relationship.name = 'plant on site'}  
property\_definition\_relationship  
property\_definition\_relationship.related\_property\_definition ->  
property\_definition =>  
sited\_plant

#### 5.1.16.10 Site\_feature

AIM element: site\_feature

Source: 227

Reference path: site\_feature <=  
property\_definition

##### 5.1.16.10.1 location\_and\_orientation

AIM element: [(axis2\_placement\_2d)  
(axis2\_placement\_3d)]  
[cartesian\_point]

Source: 42

Reference path: site\_feature <=  
property\_definition  
represented\_definition = property\_definition  
represented\_definition <=

```

property_definition_representation.definition
property_definition_representation
property_definition_representation.used_representation ->
representation
representation.items[i] ->
{representation_item
representation_item.name = 'feature orientation'}
representation_item =>
geometric_representation_item =>
[placement =>
(axis2_placement_2d)
(axis2_placement_3d)]
[placement
placement.location ->
cartesian_point
{cartesian_point <=
point <=
geometric_representation_item <=
representation_item
representation_item.name = 'feature location'}}]

```

### 5.1.16.10.2 man\_made\_or\_natural

AIM element: descriptive\_representation\_item.description

Source: 45

Reference path: site\_feature <=

```

property_definition
represented_definition = property_definition
represented_definition <-
property_definition_representation.definition
property_definition_representation
property_definition_representation.used_representation ->
representation
representation.items[i] ->
{representation_item
representation_item.name = 'origin type'}
representation_item =>
descriptive_representation_item
descriptive_representation_item.description
{(descriptive_representation_item.description = 'man made')
(descriptive_representation_item.description = 'natural')}

```

### 5.1.16.10.3 shape

AIM element: shape\_representation

Source: 41

Rules: subtype\_mandatory\_shape\_representation

Reference path: site\_feature <=

```

{property_definition =>
product_definition_shape}
property_definition
represented_definition = property_definition
represented_definition <-
property_definition_representation.definition
{property_definition_representation =>
shape_definition_representation}
property_definition_representation
property_definition_representation.used_representation ->
representation =>
shape_representation

```

#### 5.1.16.10.4 site\_feature\_id

AIM element: property\_definition.name

Source: 41

Reference path: site\_feature <=  
property\_definition  
property\_definition.name

#### 5.1.16.10.5 type

AIM element: descriptive\_representation\_item.description

Source: 45

Reference path: site\_feature <=  
property\_definition  
represented\_definition = property\_definition  
represented\_definition <-  
property\_definition\_representation.definition  
property\_definition\_representation  
property\_definition\_representation.used\_representation ->  
representation  
representation.items[i] ->  
{representation\_item  
representation\_item.name = 'site feature type'}  
representation\_item =>  
descriptive\_representation\_item  
descriptive\_representation\_item.description

#### 5.1.16.10.6 site\_feature to changed\_site\_feature

AIM element: IDENTICAL MAPPING

#### 5.1.16.11 Site\_shape\_representation

AIM element: site\_representation

Source: 227

Reference path: site\_representation <=  
shape\_representation

#### **5.1.16.11.1 site\_shape\_representation\_id**

AIM element: representation.name

Source: 43

Rules: subtype\_mandatory\_shape\_representation

Reference path: site\_representation <=  
shape\_representation <=  
representation  
representation.name

#### **5.1.16.11.2 site\_shape\_representation to breakline**

AIM element: PATH

Rules: subtype\_mandatory\_shape\_representation

Reference path: site\_representation <=  
shape\_representation <=  
representation  
representation.items[i] ->  
representation\_item =>  
geometric\_representation\_item =>  
{geometric\_set =>  
geometric\_curve\_set}  
geometric\_set  
geometric\_set.elements[i] ->  
geometric\_set\_select  
geometric\_set\_select = curve  
curve =>  
bounded\_curve =>  
polyline

#### **5.1.16.11.3 site\_shape\_representation to gis\_position**

AIM element: PATH

Rules: subtype\_mandatory\_shape\_representation

Reference path: site\_representation <=  
shape\_representation <=  
representation <-  
representation\_map.mapped\_representation  
representation\_map <-  
mapped\_item.mapping\_source  
mapped\_item <=

```

representation_item <-
representation.items[i]
representation
{representation
representation.name = 'gis position'}

```

### 5.1.16.12 Sited\_plant

AIM element: sited\_plant

Source: 227

Reference path:

```

sited_plant <=
property_definition
{property_definition
property_definition.definition ->
characterized_definition
characterized_definition = characterized_product_definition
characterized_product_definition
characterized_product_definition = product_definition
product_definition
[product_definition.formation ->
product_definition_formation
product_definition_formation.of_product ->
product =>
plant]
[product_definition.frame_of_reference ->
[product_definition_context <=
application_context_element
application_context_element.name = 'physical occurrence']
[product_definition_context
product_definition_context.life_cycle_stage = 'physical design']]

```

#### 5.1.16.12.1 plant\_site\_location

AIM element: cartesian\_point

Source: 42

Rules: subtype\_exclusive\_characterized\_object

Reference path:

```

sited_plant <=
property_definition
property_definition.definition
property_definition
represented_definition = property_definition
represented_definition <-
property_definition_representation.definition
property_definition_representation
property_definition_representation.used_representation ->
representation <-
representation_map.mapped_representation
representation_map <-

```

```

mapped_item.mapping_source
{mapped_item <=
representation_item <-
representation.items[i]
representation <-
property_definition_representation.used_representation
property_definition_representation
property_definition_representation.definition ->
represented_definition
represented_definition = property_definition
property_definition
property_definition.definition ->
characterized_definition
characterized_definition = characterized_object
characterized_object =>
site}
mapped_item
mapped_item.mapping_target ->
{representation_item
representation_item.name = 'plant orientation'}
representation_item =>
geometric_representation_item =>
{placement =>
(axis2_placement_2d)
(axis2_placement_3d)}
placement
placement.location ->
cartesian_point
{cartesian_point <=
point <=
geometric_representation_item <=
representation_item
representation_item.name = 'plant location'}
```

### 5.1.16.12.2 plant\_site\_orientation

AIM element:	(axis2_placement_2d) (axis2_placement_3d)
Source:	42
Rules:	subtype_exclusive_characterized_object
Reference path:	sited_plant <= property_definition represented_definition = property_definition represented_definition <- property_definition_representation.definition property_definition_representation property_definition_representation.used_representation -> representation <- representation_map.mapped_representation representation_map <- mapped_item.mapping_source

```

{ mapped_item <=
  representation_item <-
  representation.items[i]
  representation <-
  property_definition_representation.used_representation
  property_definition_representation
  property_definition_representation.definition ->
  represented_definition
  represented_definition = property_definition
  property_definition
  property_definition.definition ->
  characterized_definition
  characterized_definition = characterized_object
  characterized_object =>
  site }
mapped_item
mapped_item.mapping_target ->
{ representation_item
  representation_item.name = 'plant orientation' }
representation_item =>
geometric_representation_item =>
placement =>
(axis2_placement_2d)
(axis2_placement_3d)

```

### 5.1.16.12.3 sited\_plant to changed\_sited\_plant

AIM element: IDENTICAL MAPPING

### 5.1.16.13 Survey\_point

AIM element: cartesian\_point

Source: 42

Reference path: { cartesian\_point <=
 point <=
 geometric\_representation\_item <=
 representation\_item
 representation\_item.name = 'survey point' }

## 5.1.17 Global rules referenced in the mapping specification

1. application\_context\_requires\_ap\_definition
2. approval\_requires\_approval\_date\_time
3. approval\_requires\_approval\_person\_organization
4. change\_action\_requires\_date
5. change\_item\_requires\_creation\_date
6. change\_item\_requires\_id
7. change\_life\_cycle\_stage\_usage\_requires\_approval
8. change\_life\_cycle\_stage\_usage\_requires\_stage
9. dependent\_instantiable\_application\_context

10. dependent\_instantiable\_product\_context
11. dependent\_instantiable\_product\_definition\_context
12. product\_context\_discipline\_type\_constraint
13. product\_definition\_context\_name\_constraint
14. product\_definition\_usage\_constraint
15. subtype\_exclusive\_characterized\_object
16. subtype\_mandatory\_externally\_defined\_item
17. subtype\_mandatory\_pre\_defined\_item
18. subtype\_mandatory\_shape\_representation
19. value\_for\_application\_context
20. version2\_p41\_object\_role\_selection
21. version2\_p41\_uninstantiable\_basic\_attributes

## 5.2 AIM EXPRESS short listing

This clause specifies the EXPRESS schema that uses elements from the integrated resources and contains the types, entity specializations, rules, and functions that are specific to this part of ISO 10303. This clause also specifies modifications to the text for constructs that are imported from the integrated resources. The definitions and EXPRESS provided in the integrated resources for constructs used in the AIM may include select list items and subtypes that are not imported into the AIM. Requirements stated in the integrated resources that refer to such items and subtypes apply exclusively to those items which are imported into the AIM.

### EXPRESS specification:

```

*)
SCHEMA plant_spatial_configuration;

USE FROM action_schema
  (action_directive,
   action_method_relationship,
   action_relationship,
   action_request_solution,
   action_request_status,
   action_status,
   directed_action,
   versioned_action_request); -- ISO 10303-41

USE FROM application_context_schema
  (application_context,
   application_protocol_definition,
   product_context,
   product_definition_context); -- ISO 10303-41

USE FROM approval_schema
  (approval,
   approval_date_time,
   approval_person_organization); -- ISO 10303-41

USE FROM basic_attribute_schema
  (description_attribute,
   id_attribute,
   name_attribute,
   role_association); -- ISO 10303-41

USE FROM date_time_schema
  (calendar_date,
   date_and_time); -- ISO 10303-41

USE FROM document_schema
  (document,
   document_relationship,
   document_usage_constraint); -- ISO 10303-41

USE FROM external_reference_schema
  (external_source,
   externally_defined_item,
   externally_defined_item_relationship,
   pre_defined_item); -- ISO 10303-41

USE FROM geometric_model_schema
  (block,
   boolean_operator,
   boolean_operand,
   boolean_result,
   brep_with_voids,
   csg_solid,
   cyclide_segment_solid,
   eccentric_cone,
   ellipsoid,

```

```

extruded_area_solid,
extruded_face_solid,
faceted_brep,
geometric_curve_set,
geometric_set,
geometric_set_replica,
manifold_solid_brep,
rectangular_pyramid,
revolved_area_solid,
revolved_face_solid,
right_angular_wedge,
right_circular_cone,
right_circular_cylinder,
shell_based_wireframe_model,
solid_model,
sphere,
swept_face_solid,
swept_area_solid,
torus); -- ISO 10303-42

```

```

USE FROM geometry_schema
(axis2_placement_2d,
axis2_placement_3d,
b_spline_curve,
b_spline_curve_with_knots,
b_spline_surface,
b_spline_surface_with_knots,
bezier_curve,
bezier_surface,
boundary_curve,
bounded_pcurve,
bounded_surface_curve,
cartesian_point,
circle,
composite_curve,
composite_curve_on_surface,
composite_curve_segment,
conical_surface,
curve_bounded_surface,
curve_replica,
cylindrical_surface,
degenerate_pcurve,
degenerate_toroidal_surface,
direction,
ellipse,
evaluated_degenerate_pcurve,
geometric_representation_context,
geometric_representation_item,
hyperbola,
intersection_curve,
line,
offset_curve_2d,
offset_curve_3d,
offset_surface,
outer_boundary_curve,
parabola,
pcurve,
plane,
point,
point_on_curve,
point_on_surface,
point_replica,
polyline,
quasi_uniform_curve,
quasi_uniform_surface,
rational_b_spline_curve,
rational_b_spline_surface,
reparametrised_composite_curve_segment,
rectangular_composite_surface,
rectangular_trimmed_surface,

```

```

    seam_curve,
    spherical_surface,
    surface_curve,
    surface_of_linear_extrusion,
    surface_of_revolution,
    surface_patch,
    surface_replica,
    toroidal_surface,
    trimmed_curve,
    uniform_curve,
    uniform_surface); -- ISO 10303-42

```

```

USE FROM group_schema
    (group,
     group_relationship); -- ISO 10303-41

```

```

USE FROM management_resources_schema
    (action_assignment,
     action_request_assignment,
     approval_assignment,
     classification_assignment,
     date_and_time_assignment,
     date_assignment,
     document_reference,
     group_assignment,
     identification_assignment,
     name_assignment,
     organization_assignment,
     person_and_organization_assignment,
     person_assignment); -- ISO 10303-41

```

```

USE FROM material_property_definition_schema
    (characterized_material_property,
     material_designation,
     material_designation_characterization,
     material_property,
     product_material_composition_relationship,
     property_definition_relationship); -- ISO 10303-45

```

```

USE FROM material_property_representation_schema
    (material_property_representation); -- ISO 10303-45

```

```

USE FROM measure_schema
    (amount_of_substance_measure,
     amount_of_substance_measure_with_unit,
     amount_of_substance_unit,
     area_measure,
     context_dependent_measure,
     context_dependent_unit,
     conversion_based_unit,
     count_measure,
     derived_unit,
     electric_current_measure,
     electric_current_measure_with_unit,
     electric_current_unit,
     global_unit_assigned_context,
     length_measure,
     length_measure_with_unit,
     length_unit,
     luminous_intensity_measure,
     luminous_intensity_measure_with_unit,
     luminous_intensity_unit,
     mass_measure,
     mass_measure_with_unit,
     mass_unit,
     named_unit,
     numeric_measure,
     parameter_value,
     plane_angle_measure_with_unit,
     plane_angle_unit,

```

```

    positive_length_measure,
    positive_plane_angle_measure,
    positive_ratio_measure,
    ratio_measure,
    ratio_measure_with_unit,
    ratio_unit,
    si_unit,
    solid_angle_measure,
    solid_angle_measure_with_unit,
    solid_angle_unit,
    thermodynamic_temperature_measure,
    thermodynamic_temperature_measure_with_unit,
    thermodynamic_temperature_unit,
    time_measure,
    time_measure_with_unit,
    time_unit,
    volume_measure); -- ISO 10303-41

USE FROM qualified_measure_schema
    (descriptive_representation_item,
     measure_representation_item,
     qualified_representation_item,
     precision_qualifier,
     type_qualifier); -- ISO 10303-45

USE FROM person_organization_schema
    (organization,
     organizational_project); -- ISO 10303-41

USE FROM presentation_organization_schema
    (presentation_layer_assignment); -- ISO 10303-46

USE FROM presentation_resource_schema
    (colour,
     colour_rgb); -- ISO 10303-46

USE FROM product_definition_schema
    (product,
     product_definition,
     product_definition_formation,
     product_definition_formation_relationship,
     product_definition_formation_with_specified_source,
     product_definition_relationship,
     product_definition_substitute,
     product_definition_with_associated_documents); -- ISO 10303-41

USE FROM product_property_definition_schema
    (characterized_object,
     product_definition_shape,
     property_definition,
     shape_aspect,
     shape_aspect_relationship); -- ISO 10303-41

USE FROM product_property_representation_schema
    (item_identified_representation_usage,
     property_definition_representation,
     shape_definition_representation,
     shape_representation); -- ISO 10303-41

USE FROM product_structure_schema
    (assembly_component_usage,
     make_from_usage_option,
     product_definition_usage); -- ISO 10303-44

USE FROM representation_schema
    (mapped_item,
     parametric_representation_context,
     representation,
     representation_context,
     representation_item,

```

```

representation_item_relationship,
global_uncertainty_assigned_context); -- ISO 10303-43

USE FROM shape_aspect_definition_schema
(centre_of_symmetry,
derived_shape_aspect,
symmetric_shape_aspect); -- ISO 10303-41

USE FROM shape_dimension_schema
(angular_location,
dimensional_characteristic_representation,
dimensional_location,
dimensional_size,
shape_dimension_representation); -- ISO 10303-47

USE FROM topology_schema
(connected_face_set,
edge,
edge_curve,
edge_loop,
face,
face_bound,
face_outer_bound,
face_surface,
loop,
oriented_closed_shell,
oriented_edge,
oriented_open_shell,
path,
poly_loop,
topological_representation_item,
vertex_shell,
wire_shell); -- ISO 10303-42
( *
```

NOTE The schemas referenced above can be found in the following parts of ISO 10303:

action_schema	ISO 10303-41
application_context_schema	ISO 10303-41
approval_schema	ISO 10303-41
date_time_schema	ISO 10303-41
document_schema	ISO 10303-41
external_reference_schema	ISO 10303-41
geometric_model_schema	ISO 10303-42
geometry_schema	ISO 10303-42
group_schema	ISO 10303-41
management_resources_schema	ISO 10303-41
material_property_definition_schema	ISO 10303-45
measure_schema	ISO 10303-41
person_organization_schema	ISO 10303-41

presentation_organization_schema	ISO 10303-46
presentation_resource_schema	ISO 10303-46
product_definition_schema	ISO 10303-41
product_property_definition_schema	ISO 10303-41
product_property_representation_schema	ISO 10303-41
product_structure_schema	ISO 10303-44
qualified_measure_schema	ISO 10303-45
representation_schema	ISO 10303-43
shape_aspect_definition_schema	ISO 10303-47
shape_dimension_schema	ISO 10303-47
topology_schema	ISO 10303-42

## 5.2.1 Fundamental concepts and assumptions

### 5.2.1.1 property\_definition, representation and representation\_item

For a given item, non-shape properties are handled through a combination of **property\_definition**, **representation**, and **representation\_item**. All non-shape properties are grouped together and evaluated by a function for consistency. The **property\_definition** serves as an aggregator of property values for a particular object. The **representation** collects individual elements of representation, usually in the form of name, value pairs that are applicable to a particular **property\_definition**. The **representation\_item** specifies a specific characteristic and its value. Shape properties are dealt with as a subtype and evaluated separately using **shape\_definition**.

### 5.2.1.2 identifiers and types

Any identifier is used to differentiate between instances of an entity with respect to a scope of use or implementation of the identifier. If used in data exchange, the value of the identifier shall be unique within the exchange file and, additionally, may be unique between the partners in the exchange.

**EXAMPLE 1** **Representation\_context.context\_identifier** may be any user-defined identifier that is used to differentiate contexts. REPCXT1, for example, may identify a **representation\_context**.

Any type is used to specify the intent of the instance.

**EXAMPLE 2** **Representation\_context.context\_type** may be 'parametric' if the geometry of a part is represented parametrically.

### 5.2.1.3 units

Units for a particular dimension specified in this part of ISO 10303 must be either globally specified or individually specified for each dimensional value. Different kinds of dimensions (e.g., length versus

weight), however, may be either specified globally or locally.

### 5.2.1.4 connector and connection

Connectors are **shape\_aspects** of the plant items that they belong to because they cannot exist independently. Connections are, therefore, a **shape\_aspect\_relationship**. Connections are also a **shape\_aspect** of the assembly that contains the connection, so connections are also **shape\_aspects**.

## 5.2.2 Plant spatial configuration type definitions

### 5.2.2.1 approval\_item

An **approval\_item** identifies a **change\_action**, **piping\_system**, or **versioned\_action\_request** that is assigned an approval status.

EXPRESS specification:

```
* )
TYPE approval_item = SELECT
  (change_action,
   piping_system,
   versioned_action_request);
END_TYPE;
( *
```

### 5.2.2.2 change\_item

A **change\_item** identifies the **assembly\_component\_usage**, **axis\_placement\_2d**, **axis\_placement\_3d**, **document**, **ducting\_system**, **electrical\_system**, **externally\_defined\_plant\_item\_definition**, **instrumentation\_and\_control\_system**, **line\_branch\_connection**, **line\_plant\_item\_branch\_connection**, **line\_plant\_item\_connection**, **line\_termination\_connection**, **piping\_system**, **plant**, **plant\_item\_connection**, **plant\_item\_connector**, **plant\_line\_definition**, **plant\_line\_segment\_definition**, **plant\_line\_segment\_termination**, **process\_capability**, **product**, **product\_definition**, **product\_definition\_relationship**, **product\_definition\_shape**, **property\_definition**, **reference\_geometry**, **site**, **site\_feature**, **sited\_plant**, or **structural\_system** that can be modified, for which there is a request to modify, or that is the result of a change.

EXPRESS specification:

```
* )
TYPE change_item = SELECT
  (assembly_component_usage,
   axis2_placement_2d,
   axis2_placement_3d,
   document,
   ducting_system,
   electrical_system,
   externally_defined_plant_item_definition,
   instrumentation_and_control_system,
   line_branch_connection,
   line_plant_item_branch_connection,
   line_plant_item_connection,
   line_termination_connection,
   piping_system,
   plant,
   plant_item_connection,
   plant_item_connector,
   plant_line_definition,
```

```

    plant_line_segment_definition,
    plant_line_segment_termination,
    process_capability,
    product,
    product_definition,
    product_definition_relationship,
    product_definition_shape,
    property_definition,
    reference_geometry,
    site,
    site_feature,
    sited_plant,
    structural_system);
END_TYPE;
( *

```

### 5.2.2.3 change\_life\_cycle\_item

A **change\_life\_cycle\_item** identifies the **directed\_action** that is classified.

EXPRESS specification:

```

*)
TYPE change_life_cycle_item = SELECT
    (directed_action);
END_TYPE;
( *

```

### 5.2.2.4 classification\_item

A **classification\_item** identifies the **cableway\_system**, **ducting\_system**, **electrical\_system**, **hvac\_component\_definition**, **hvac\_connector**, **instrumentation\_and\_control\_system**, **piping\_component\_definition**, **piping\_system**, **plant\_item\_connection**, **plant\_item\_connector**, **applied\_document\_reference**, **product**, **product\_definition**, or **structural\_system** that is classified.

EXPRESS specification:

```

*)
TYPE classification_item = SELECT
    (cableway_system,
     ducting_system,
     electrical_system,
     hvac_component_definition,
     hvac_connector,
     instrumentation_and_control_system,
     piping_component_definition,
     piping_system,
     plant_item_connection,
     plant_item_connector,
     applied_document_reference,
     product,
     product_definition,
     structural_system);
END_TYPE;
( *

```

### 5.2.2.5 design\_project\_item

A **design\_project\_item** identifies the **product\_definition** that is assigned to a **design\_project**.

EXPRESS specification:

```

*)
TYPE design_project_item = SELECT
    (product_definition);
END_TYPE;
( *

```

**5.2.2.6 action\_request\_item**

An **action\_request\_item** identifies the **product** that is assigned to an **action\_request**, indicating a request for purchase.

EXPRESS specification:

```

*)
TYPE action_request_item = SELECT
    (product);
END_TYPE;
( *

```

**5.2.2.7 date\_and\_time\_item**

A **date\_and\_time\_item** identifies the **product** that a **date\_and\_time** is assigned to.

EXPRESS specification:

```

*)
TYPE date_and_time_item = SELECT
    (change_action,
     change_item,
     change_life_cycle_stage_assignment,
     product);
END_TYPE;
( *

```

**5.2.2.8 dated\_item**

A **dated\_item** identifies the **action\_directive**, **change\_action**, **change\_item**, or **product** that a date is assigned to.

EXPRESS specification:

```

*)
TYPE dated_item = SELECT
    (action_directive,
     change_action,
     change_item,
     product);
END_TYPE;
( *

```

**5.2.2.9 document\_item**

A **document\_item** identifies the **externally\_defined\_plant\_item\_definition**, **heat\_tracing\_representation**, **material\_property**, **piping\_component\_class**, **piping\_system**, **plant\_item\_connector**, **plant\_line\_segment\_definition**, **product**, **product\_definition**, **product\_definition\_relationship**,

**property\_definition**, **representation**, **representation\_item**, or **site** that is associated with a **document**.

EXPRESS specification:

```
*)
TYPE document_item = SELECT
  (externally_defined_plant_item_definition,
   heat_tracing_representation,
   material_property,
   piping_component_class,
   piping_system,
   plant_item_connector,
   plant_line_segment_definition,
   product,
   product_definition,
   product_definition_relationship,
   property_definition,
   representation,
   representation_item,
   site);
END_TYPE;
( *
```

### 5.2.2.10 identified\_item

An **identified\_item** identifies the **document**, **material\_property**, **product\_definition**, or **shape\_aspect** to which an identifier is assigned.

EXPRESS specification:

```
*)
TYPE identified_item = SELECT
  (document,
   material_property,
   product_definition,
   shape_aspect);
END_TYPE;
( *
```

### 5.2.2.11 plant\_spatial\_configuration\_organization\_item

A **plant\_spatial\_configuration\_organization\_item** identifies the **catalogue**, **change\_action**, **design\_project**, **document**, **plant**, **product\_definition\_formation**, **product\_definition\_relationship**, or **site** that is associated with an **organization**.

EXPRESS specification:

```
*)
TYPE plant_spatial_configuration_organization_item = SELECT
  (catalogue,
   change_action,
   design_project,
   document,
   plant,
   product_definition_formation,
   product_definition_relationship,
   representation,
   site);
END_TYPE;
( *
```

### 5.2.2.12 plant\_spatial\_configuration\_person\_item

A **plant\_spatial\_configuration\_person\_item** identifies the **document**, **plant**, **product\_definition\_relationship**, or **site** that is associated with a **person**.

EXPRESS specification:

```
*)
TYPE plant_spatial_configuration_person_item = SELECT
  (document,
   plant,
   product_definition_relationship,
   representation,
   site);
END_TYPE;
( *
```

### 5.2.2.13 plant\_spatial\_configuration\_person\_and\_organization\_item

A **plant\_spatial\_configuration\_person\_and\_organization\_item** identifies the **change\_item**, **plant**, or **site** that is associated with a **person\_and\_organization**.

EXPRESS specification:

```
*)
TYPE plant_spatial_configuration_person_and_organization_item = SELECT
  (change_item,
   plant,
   site);
END_TYPE;
( *
```

### 5.2.2.14 purchase\_item

A **purchase\_item** identifies a **product** that is purchased.

EXPRESS specification:

```
*)
TYPE purchase_item = SELECT
  (product);
END_TYPE;
( *
```

## 5.2.3 Plant spatial configuration entities

### 5.2.3.1 Plant spatial configuration entity definitions

#### 5.2.3.1.1 action\_request\_assignment

A **applied\_action\_request\_assignment** assigns an **action\_request** to a set of one or more **products**.

```
*)
ENTITY applied_action_request_assignment
  SUBTYPE OF (action_request_assignment);
  items : SET [1:?] OF action_request_item;
END_ENTITY;
( *
```

Attribute definitions:

**items**: the set of **products** that an **action\_request** is assigned to.

### 5.2.3.1.2 applied\_approval\_assignment

An **applied\_approval\_assignment** assigns an **approval** to a set of one or more **change\_actions**.

EXPRESS specification:

```
*)
ENTITY applied_approval_assignment
  SUBTYPE OF (approval_assignment);
  items : SET [1:?] OF approval_item;
END_ENTITY;
(*
```

Attribute definitions:

**items**: the set of instances of **change\_action**, **piping\_system**, or **versioned\_action\_request** to which an **approval** is assigned.

Associated global rule:

The following global rule defined in this part of ISO 10303 applies to the **applied\_approval\_assignment** entity:

- **change\_life\_cycle\_stage\_usage\_requires\_approval** (see 5.2.4.7).

### 5.2.3.1.3 applied\_classification\_assignment

An **applied\_classification\_assignment** assigns a classification to a **cableway\_system**, **ducting\_system**, **electrical\_system**, **hvac\_component\_definition**, **hvac\_connector**, **instrumentation\_and\_control\_system**, **piping\_component\_definition**, **piping\_system**, **plant\_item\_connection**, **plant\_item\_connector**, **applied\_document\_reference**, **product**, **product\_definition**, or **structural\_system**.

EXPRESS specification:

```
*)
ENTITY applied_classification_assignment
  SUBTYPE OF (classification_assignment);
  items : SET [1:?] OF classification_item;
WHERE
  WR1: (NOT (SIZEOF (QUERY (item <* SELF.items |
    NOT ('PLANT_SPATIAL_CONFIGURATION.PLANT_ITEM_CONNECTION' IN
    TYPEOF(item)))) = 0)) OR
    (SIZEOF (TYPEOF (SELF.assigned_class) *
    ['PLANT_SPATIAL_CONFIGURATION.CONNECTION_FUNCTIONAL_CLASS',
    'PLANT_SPATIAL_CONFIGURATION.CONNECTION_MOTION_CLASS'])
    >= 1);
  WR2: (NOT (SIZEOF (QUERY (item <* SELF.items |
    NOT ('PLANT_SPATIAL_CONFIGURATION.PLANT_ITEM_CONNECTOR' IN
    TYPEOF(item)))) = 0)) OR
    (SIZEOF (TYPEOF (SELF.assigned_class) *
    ['PLANT_SPATIAL_CONFIGURATION.CONNECTOR_END_TYPE_CLASS',
    'PLANT_SPATIAL_CONFIGURATION.ELECTRICAL_CONNECTOR_CLASS',
    'PLANT_SPATIAL_CONFIGURATION.PIPING_CONNECTOR_CLASS',
    'PLANT_SPATIAL_CONFIGURATION.EXTERNALLY_DEFINED_CLASS',
    'PLANT_SPATIAL_CONFIGURATION.' +
```

```

        'STRUCTURAL_LOAD_CONNECTOR_CLASS']] >= 1);
WR3: (NOT (SIZEOF (QUERY (item <* SELF.items |
NOT ('PLANT_SPATIAL_CONFIGURATION.PIPING_COMPONENT_DEFINITION' IN
TYPEOF(item)))) = 0)) OR
(SIZEOF (TYPEOF (SELF.assigned_class) *
['PLANT_SPATIAL_CONFIGURATION.BLANK_FITTING_CLASS',
'PLANT_SPATIAL_CONFIGURATION.ELBOW_FITTING_CLASS',
'PLANT_SPATIAL_CONFIGURATION.FLANGE_FITTING_CLASS',
'PLANT_SPATIAL_CONFIGURATION.' +
'FLANGE_FITTING_NECK_TYPE_CLASS',
'PLANT_SPATIAL_CONFIGURATION.PIPE_CLOSURE_FITTING_CLASS',
'PLANT_SPATIAL_CONFIGURATION.PIPE_CLASS',
'PLANT_SPATIAL_CONFIGURATION.REDUCER_FITTING_CLASS',
'PLANT_SPATIAL_CONFIGURATION.SPACER_FITTING_CLASS',
'PLANT_SPATIAL_CONFIGURATION.SPECIALTY_ITEM_CLASS',
'PLANT_SPATIAL_CONFIGURATION.SWAGE_FITTING_CLASS',
'PLANT_SPATIAL_CONFIGURATION.VALVE_CLASS']) >= 1);
END_ENTITY;
( *

```

#### Attribute definitions:

**items:** the set of **cableway\_system**, **ducting\_system**, **electrical\_system**, **hvac\_component\_definition**, **hvac\_connector**, **instrumentation\_and\_control\_system**, **piping\_component\_definition**, **piping\_system**, **plant\_item\_connection**, **plant\_item\_connector**, **applied\_document\_reference**, **product**, **product\_definition**, or **structural\_system** instances that are assigned to a group.

#### Formal propositions:

**WR1:** A **plant\_item\_connection** shall be assigned either a **connection\_functional\_class**, a **connection\_motion\_class**, or a combination of these.

**WR2:** A **plant\_item\_connector** shall be assigned either a **connector\_end\_type\_class**, **electrical\_connector\_class**, **piping\_connector\_class**, **structural\_load\_connector\_class**, or a combination of these.

**WR3:** A **piping\_component\_definition** shall be assigned either a **blank\_fitting\_class**, **elbow\_fitting\_class**, **flange\_fitting\_class**, **flange\_fitting\_neck\_type\_class**, **pipe\_closure\_fitting\_class**, **pipe\_class**, **reducer\_fitting\_class**, **spacer\_fitting\_class**, **specialty\_item\_class**, **swage\_fitting\_class**, **valve\_class**, or a combination of these.

### 5.2.3.1.4 applied\_date\_and\_time\_assignment

An **applied\_date\_and\_time\_assignment** assigns a **date\_and\_time** to a set of one or more **products**.

#### EXPRESS specification:

```

*)
ENTITY applied_date_and_time_assignment
  SUBTYPE OF (date_and_time_assignment);
  items : SET [1:?] OF date_and_time_item;
END_ENTITY;
( *

```

#### Attribute definitions:

**items:** the set of **products** that a **date\_and\_time** is assigned to.

### 5.2.3.1.5 applied\_date\_assignment

An **applied\_date\_assignment** assigns a **date** to a set of one or more **action\_directives**, **change\_actions**, **change\_items**, and **products**.

EXPRESS specification:

```
*)
ENTITY applied_date_assignment
  SUBTYPE OF (date_assignment);
  items : SET [1:?] OF dated_item;
END_ENTITY;
( *
```

Attribute definitions:

**items**: the set of **action\_directives**, **change\_actions**, **change\_items**, and **products** that a **date** is assigned to.

Associated global rules:

The following global rules defined in this part of ISO 10303 apply to the **applied\_date\_assignment** entity:

- **change\_action\_requires\_date** (see 5.2.4.4);
- **change\_item\_requires\_creation\_date** (see 5.2.4.5).

### 5.2.3.1.6 applied\_document\_reference

An **applied\_document\_reference** assigns a document to a set of one or more instances of **heat\_tracing\_representation**, **piping\_component\_class**, **piping\_system**, **plant\_item\_connector**, **plant\_line\_segment\_definition**, **product**, **product\_definition**, **product\_definition\_relationship**, **property\_definition**, **representation**, **representation\_item**, **site**, **externally\_defined\_plant\_item\_definition**, or **material\_property**.

EXPRESS specification:

```
*)
ENTITY applied_document_reference
  SUBTYPE OF (document_reference);
  items : SET [1:?] OF document_item;
END_ENTITY;
( *
```

Attribute definitions:

**items**: the set of instances of **heat\_tracing\_representation**, **piping\_component\_class**, **piping\_system**, **plant\_item\_connector**, **plant\_line\_segment\_definition**, **product**, **product\_definition**, **product\_definition\_relationship**, **property\_definition**, **representation**, **representation\_item**, **site**, **externally\_defined\_plant\_item\_definition**, or **material\_property** that is associated with a **document**.

### 5.2.3.1.7 applied\_identification\_assignment

A **applied\_identification\_assignment** assigns an identifier to a set of one or more instances of **document**,

**material\_property**, **product\_definition**, or **shape\_aspect**.

EXPRESS specification:

```
*)
ENTITY applied_identification_assignment
  SUBTYPE OF (identification_assignment);
  items : SET [1:?] OF identified_item;
WHERE
  WR1: applied_identification_correlation (SELF);
END_ENTITY;
( *
```

Attribute definitions:

**items**: the set of instances of **product\_definition**, **material\_property**, or **document** that an identifier is assigned to.

Formal propositions:

**WR1**: The **applied\_identification\_correlation** function that correlates roles of identifiers to elements of product data shall be satisfied.

### 5.2.3.1.8 blank\_fitting\_class

A **blank\_fitting\_class** is a type of **group** that classifies the items that are assigned to it as blank fittings.

EXPRESS specification:

```
*)
ENTITY blank_fitting_class
  SUBTYPE OF (group);
WHERE
  WR1: SIZEOF (QUERY (aca <* QUERY (ca <* USEDIN (SELF,
    'PLANT_SPATIAL_CONFIGURATION.CLASSIFICATION_ASSIGNMENT.' +
    'ASSIGNED_CLASS') |
    'PLANT_SPATIAL_CONFIGURATION.APPLIED_CLASSIFICATION_ASSIGNMENT' IN
    TYPEOF (ca)) |
    NOT (SIZEOF (QUERY (it <* aca.items |
    NOT ('PLANT_SPATIAL_CONFIGURATION.PIPING_COMPONENT_DEFINITION' IN
    TYPEOF (it)))) = 0))) = 0;
  WR2: SIZEOF (QUERY (aca <* QUERY (ca <* USEDIN (SELF,
    'PLANT_SPATIAL_CONFIGURATION.CLASSIFICATION_ASSIGNMENT.' +
    'ASSIGNED_CLASS') |
    'PLANT_SPATIAL_CONFIGURATION.APPLIED_CLASSIFICATION_ASSIGNMENT' IN
    TYPEOF (ca)) |
    NOT (SIZEOF (QUERY (pcd <* QUERY (it <* aca.items |
    'PLANT_SPATIAL_CONFIGURATION.PIPING_COMPONENT_DEFINITION' IN
    TYPEOF (it)) |
    NOT (SIZEOF (QUERY (aca1 <* USEDIN (pcd.formation.of_product,
    'PLANT_SPATIAL_CONFIGURATION.' +
    'APPLIED_CLASSIFICATION_ASSIGNMENT.ITEMS') |
    class_in_tree (aca1.assigned_class, 'blank')) = 1))) = 0
    ))) = 0;
END_ENTITY;
( *
```

Formal propositions:

**WR1**: A **blank\_fitting\_class** shall classify items of type **pipng\_component\_definition**.

**WR2**: A **blank\_fitting\_class** shall classify items of type **pipng\_component\_definition** that are a

definition of a **product** that is classified as a 'blank'.

### 5.2.3.1.9 bolt\_and\_nut\_component\_class

A **bolt\_and\_nut\_component\_class** is a type of **group** that classifies the items that are assigned to it as bolts, nuts, or washers.

EXPRESS specification:

```
*)
ENTITY bolt_and_nut_component_class
  SUBTYPE OF (group);
WHERE
  WR1: SIZEOF (QUERY (aca <* QUERY (ca <* USEDIN (SELF,
    'PLANT_SPATIAL_CONFIGURATION.CLASSIFICATION_ASSIGNMENT.' +
    'ASSIGNED_CLASS') |
    'PLANT_SPATIAL_CONFIGURATION.APPLIED_CLASSIFICATION_ASSIGNMENT' IN
    TYPEOF (ca)) |
    NOT (SIZEOF (QUERY (it <* aca.items |
    NOT ('PLANT_SPATIAL_CONFIGURATION.BOLT_AND_NUT_COMPONENT_DEFINITION'
    IN TYPEOF (it)))) = 0))) = 0;
  WR2: SIZEOF (QUERY (aca <* QUERY (ca <* USEDIN (SELF,
    'PLANT_SPATIAL_CONFIGURATION.CLASSIFICATION_ASSIGNMENT.' +
    'ASSIGNED_CLASS') |
    'PLANT_SPATIAL_CONFIGURATION.APPLIED_CLASSIFICATION_ASSIGNMENT' IN
    TYPEOF (ca)) |
    NOT (SIZEOF (QUERY (pcd <* QUERY (it <* aca.items |
    'PLANT_SPATIAL_CONFIGURATION.BOLT_AND_NUT_COMPONENT_DEFINITION' IN
    TYPEOF (it)) |
    NOT (SIZEOF (QUERY (acal <* USEDIN (pcd.formation.of_product,
    'PLANT_SPATIAL_CONFIGURATION.' +
    'APPLIED_CLASSIFICATION_ASSIGNMENT.ITEMS') |
    class_in_tree (acal.assigned_class,
    'bolt and nut component')))) = 1))) = 0
    ))) = 0;
END_ENTITY;
(*
```

Formal propositions:

**WR1:** A **bolt\_and\_nut\_component\_class** shall classify items of type **bolt\_and\_nut\_component\_definition**.

**WR2:** A **bolt\_and\_nut\_component\_class** shall classify items of type **pipng\_component\_definition** that are a definition of a **product** that is classified as a 'bolt and nut component'.

### 5.2.3.1.10 bolt\_and\_nut\_component\_definition

A **bolt\_and\_nut\_component\_definition** is a type of **product\_definition** that defines a bolt and nut component.

EXPRESS specification

```
*)
ENTITY bolt_and_nut_component_definition
  SUBTYPE OF (product_definition);
END_ENTITY;
(*
```

### 5.2.3.1.11 bolt\_and\_nut\_set\_definition

A **bolt\_and\_nut\_set\_definition** is a type of **product\_definition** that defines a bolt and nut set.

#### EXPRESS specification

```
*)
ENTITY bolt_and_nut_set_definition
  SUBTYPE OF (product_definition);
END_ENTITY;
(*
```

### 5.2.3.1.12 cableway\_component\_class

A **cableway\_component\_class** is a type of **group** that classifies the items that are assigned to it as cableway components. The name of the **cableway\_component\_class** further classifies the assigned items.

#### EXPRESS specification:

```
*)
ENTITY cableway_component_class
  SUBTYPE OF (group);
WHERE
  WR1: SIZEOF (QUERY (aca <* QUERY (ca <* USEDIN (SELF,
    'PLANT_SPATIAL_CONFIGURATIONS.' +
    'CLASSIFICATION_ASSIGNMENT.ASSIGNED_CLASS') |
    'PLANT_SPATIAL_CONFIGURATIONS.APPLIED_CLASSIFICATION_ASSIGNMENT' IN
    TYPEOF (ca)) |
    NOT (SIZEOF (QUERY (it <* aca.items |
    NOT ('PLANT_SPATIAL_CONFIGURATIONS.CABLEWAY_COMPONENT_DEFINITION' IN
    TYPEOF (it)))) = 0))) = 0;
  WR2: SIZEOF (QUERY (aca <* QUERY (ca <* USEDIN (SELF,
    'PLANT_SPATIAL_CONFIGURATIONS.CLASSIFICATION_ASSIGNMENT.' +
    'ASSIGNED_CLASS') |
    'PLANT_SPATIAL_CONFIGURATIONS.APPLIED_CLASSIFICATION_ASSIGNMENT' IN
    TYPEOF (ca)) |
    NOT (SIZEOF (QUERY (pcd <* QUERY (it <* aca.items |
    'PLANT_SPATIAL_CONFIGURATIONS.PIPING_COMPONENT_DEFINITION' IN
    TYPEOF (it)) |
    NOT (SIZEOF (QUERY (acal <* USEDIN (pcd.formation.of_product,
    'PLANT_SPATIAL_CONFIGURATIONS.' +
    'APPLIED_CLASSIFICATION_ASSIGNMENT.ITEMS') |
    class_in_tree (acal.assigned_class, 'cableway component')) = 1))) =
    0))) = 0;
END_ENTITY;
(*
```

#### Formal propositions:

**WR1:** A **cableway\_component\_class** shall classify items of type **cableway\_component\_definition**.

**WR2:** A **cableway\_component\_class** shall classify items of type **cableway\_component\_definition** that are a definition of a **product** that is classified as a 'cableway component'.

### 5.2.3.1.13 cableway\_component\_definition

A **cableway\_component\_definition** is a type of **product\_definition** that defines a cableway component.

EXPRESS specification

```

*)
ENTITY cableway_component_definition
  SUBTYPE OF (product_definition);
END_ENTITY;
( *

```

**5.2.3.1.14 cableway\_connector\_class**

A **cableway\_connector\_class** is a type of **group** that classifies the items that are assigned to it as being cableway connectors.

EXPRESS specification:

```

*)
ENTITY cableway_connector_class
  SUBTYPE OF (group);
END_ENTITY;
( *

```

**5.2.3.1.15 cableway\_system**

A **cableway\_system** is a type of **product\_definition** that identifies a system ... *(to be completed when corresponding clause 4.2 definition is available)*.

EXPRESS specification:

```

*)
ENTITY cableway_system
  SUBTYPE OF (product_definition);
WHERE
  WR1: SIZEOF (QUERY (pdr <* USEDIN (SELF, 'PLANT_SPATIAL_CONFIGURATION.' +
    'PRODUCT_DEFINITION_RELATIONSHIP.RELATED_PRODUCT_DEFINITION') |
    ('PLANT_SPATIAL_CONFIGURATION.PLANT' IN TYPEOF
    (pdr.relatng_product_definition.formation.of_product)) AND
    (pdr.relatng_product_definition.frame_of_reference.name =
    'functional occurrence')))) = 1;
END_ENTITY;
( *

```

Formal propositions:

**WR1:** The **cableway\_system** shall be related to exactly one **product\_definition** that is the definition of a plant and has a context of 'functional occurrence'.

**5.2.3.1.16 catalogue**

A **catalogue** is a type of **document** defined as an **external\_source** that records items whose characteristics are standardized.

**NOTE** Whether the catalogue is a paper-based or digitally-based catalogue is indicated by the value of the attribute **document\_type.product\_data\_type**. **document\_type** is referenced the attribute **kind** inherited from **document**, a supertype of **catalogue**.

EXPRESS specification:

```

*)
ENTITY catalogue

```

```

    SUBTYPE OF (document, external_source);
END_ENTITY;
( *

```

### 5.2.3.1.17 catalogue\_connector

A **catalogue\_connector** is a type of **shape\_aspect** that is externally defined and identifies a connector whose characteristics are standardised in a library or catalogue.

#### EXPRESS specification:

```

*)
ENTITY catalogue_connector
    SUBTYPE OF (shape_aspect, externally_defined_item);
WHERE
    WR1: 'PLANT_SPATIAL_CONFIGURATION.CHARACTERIZED_OBJECT' IN
        TYPEOF (SELF.of_shape);
    WR2: 'PLANT_SPATIAL_CONFIGURATION.CATALOGUE' IN TYPEOF (SELF.source);
END_ENTITY;
( *

```

#### Formal propositions:

**WR1:** The **catalogue\_connector** shall be an aspect of the shape of a **characterized\_object**.

**WR2:** The **catalogue\_connector** shall have a **catalogue** as its source.

#### Associated global rule:

The following global rule defined in this part of ISO 10303 applies to the **catalogue\_connector** entity:

- **subtype\_mandatory\_externally\_defined\_item** (see 5.2.4.16).

### 5.2.3.1.18 catalogue\_item

A **catalogue\_item** is an **externally\_defined\_plant\_item\_definition** that identifies an item whose characteristics are standardized and have been recorded in a library or catalogue.

#### EXPRESS specification:

```

*)
ENTITY catalogue_item
    SUBTYPE OF (externally_defined_plant_item_definition);
WHERE
    WR1: 'PLANT_SPATIAL_CONFIGURATION.CATALOGUE' IN TYPEOF (SELF.source);
    WR2: SELF.frame_of_reference.name = 'physical definition';
END_ENTITY;
( *

```

#### Formal propositions:

**WR1:** A **catalogue\_item** shall have a **catalogue** as the **external\_source**.

**WR2:** A **catalogue\_item** shall have a **frame\_of\_reference name** of 'catalogue definition'.

#### Associated global rules:

The following global rules defined in this part of ISO 10303 apply to the **catalogue\_item** entity:

- **application\_context\_requires\_ap\_definition** (see 5.2.4.1);
- **dependent\_instantiable\_application\_context** (see 5.2.4.9);
- **dependent\_instantiable\_product\_definition\_context** (see 5.2.4.11);
- **product\_definition\_context\_name\_constraint** (see 5.2.4.13);
- **subtype\_mandatory\_externally\_defined\_item** (see 5.2.4.16).

### 5.2.3.1.19 change\_action

A **change\_action** is a type of **directed\_action** that identifies a change, or a request for a change.

EXPRESS specification:

```
*)
ENTITY change_action
  SUBTYPE OF (directed_action);
WHERE
  WR1: SIZEOF (QUERY (ca <* USEDIN (SELF, 'PLANT_SPATIAL_CONFIGURATION.' +
    'ACTION_ASSIGNMENT.ASSIGNED_ACTION') |
    'PLANT_SPATIAL_CONFIGURATION.' +
    'PLANT_SPATIAL_CONFIGURATION_CHANGE_ASSIGNMENT' IN
    TYPEOF (ca))) >= 1;
  WR2: SIZEOF (QUERY (ar <* SELF\directed_action.directive.requests |
    NOT (SIZEOF (USEDIN (ar, 'PLANT_SPATIAL_CONFIGURATION.' +
    'ACTION_REQUEST_SOLUTION.REQUEST')) = 1))) = 0;
  WR3: SIZEOF (USEDIN (SELF, 'PLANT_SPATIAL_CONFIGURATION.ACTION_STATUS.' +
    'ASSIGNED_ACTION')) = 1;
END_ENTITY;
(*
```

Formal propositions:

**WR1:** A **change\_action** shall be assigned by at least one **plant\_spatial\_configuration\_change\_assignment**.

**WR2:** Each **versioned\_action\_request** that is referenced by a **change\_action** shall have exactly one **action\_request\_solution**.

**WR3:** Each **change\_action** shall be assigned exactly one **action\_status**.

Associated global rules:

The following global rules defined in this part of ISO 10303 apply to the **change\_action** entity:

- **change\_action\_requires\_date** (see 5.2.4.4);

### 5.2.3.1.20 change\_item\_id\_assignment

A **change\_item\_id\_assignment** assigns a name to a set of one or more instances selected by **change\_item**.

EXPRESS specification:

```
*)
ENTITY change_item_id_assignment
```

```

    SUBTYPE OF (name_assignment);
    items : SET [1:?] OF change_item;
END_ENTITY;
( *

```

Attribute definitions:

**items:** the set of instances selected by **change\_item** to which a name is assigned.

Associated global rule:

The following global rule defined in this part of ISO 10303 applies to the **change\_item\_id\_assignment** entity:

- **change\_item\_requires\_id** (see 5.2.4.6).

### 5.2.3.1.21 change\_life\_cycle\_stage\_assignment

A **change\_life\_cycle\_stage\_assignment** is a type of **group\_assignment** that classifies a **directed\_action** with a life cycle stage class.

EXPRESS specification:

```

*)
ENTITY change_life_cycle_stage_assignment
    SUBTYPE OF (group_assignment);
    items : SET [1:?] OF change_life_cycle_item;
END_ENTITY;
( *

```

Attribute definitions:

**items:** One or more **directed\_action** that is being classified according to a class of life cycle stage by the assigned\_group.

### 5.2.3.1.22 clamp\_component\_definition

A **clamp\_component\_definition** is a type of **product\_definition** that defines a clamp used to make a connection between plant items.

EXPRESS specification

```

*)
ENTITY clamp_component_definition
    SUBTYPE OF (product_definition);
END_ENTITY;
( *

```

### 5.2.3.1.23 clamp\_set\_definition

A **clamp\_set\_definition** is a type of **product\_definition** that defines a collection of clamp components.

EXPRESS specification

```

*)
ENTITY clamp_set_definition
    SUBTYPE OF (product_definition);
    END_ENTITY;

```

( \*

#### 5.2.3.1.24 connection\_functional\_class

A **connection\_functional\_class** is a type of **group** that classifies items that are assigned to it as belonging to a common functional class of connections.

EXPRESS specification:

```
* )
ENTITY connection_functional_class
  SUBTYPE OF (group);
END_ENTITY;
( *
```

#### 5.2.3.1.25 connection\_material\_definition

A **connection\_material\_definition** is a type of **product\_definition** that defines a connection material.

EXPRESS specification

```
* )
ENTITY connection_material_definition
  SUBTYPE OF (product_definition);
END_ENTITY;
( *
```

#### 5.2.3.1.26 connection\_motion\_class

A **connection\_motion\_class** is a type of **group** that classifies the connection motion of the items that are assigned to it.

EXPRESS specification:

```
* )
ENTITY connection_motion_class
  SUBTYPE OF (group);
WHERE
  WR1: SELF.name IN ['flexible', 'locked orientation'];
END_ENTITY;
( *
```

Formal propositions:

**WR1:** The name of the **connection\_motion\_class** shall be 'flexible' or 'locked orientation'.

#### 5.2.3.1.27 connection\_node

A **connection\_node** is a type of **shape\_aspect** that is part of the definition of a piping system, and connects more than one **line\_termination\_connections**.

A **connection\_node** shall be used for a connection that involves the termination of more than two lines at a single point. The **connection\_node** is the junction for each of the line to line terminations that are involved in the line to line connection.

**NOTE** There is a 2 or more cardinality between the line connection and line termination. The most common case is

that two line terminations are connected by a line connection, but there are branches where more than 2 lines are terminated at a single line connection. For the case of two lines being terminated, the line to line connection is simply a connection relationship between 2 line terminations. For the more than two, there needs to be a **shape\_aspect** that models the connection point at which all of the line terminations are connected. This connection point is represented by the **connection\_node**. The **connection\_node** represents the logical connection point for all line terminations within a single line connection when there are more than two lines being connected in a single connection.

#### EXPRESS specification:

```

*)
ENTITY connection_node
  SUBTYPE OF (shape_aspect);
WHERE
  WR1: 'PLANT_SPATIAL_CONFIGURATION.PIPING_SYSTEM'
    IN TYPEOF (SELF.of_shape.definition);
  WR2: SIZEOF (QUERY (sar <* USEDIN (SELF,
    'PLANT_SPATIAL_CONFIGURATION.SHAPE_ASPECT_RELATIONSHIP.' +
    'RELATING_SHAPE_ASPECT') |
    'PLANT_SPATIAL_CONFIGURATION.LINE_TERMINATION_CONNECTION' IN
    TYPEOF (sar))) >= 2;
END_ENTITY;
( *
```

#### Formal propositions:

**WR1:** A **connection\_node** shall be an aspect of the definition of the shape of a **pipng\_system**.

**WR2:** A **connection\_node** shall be the **relating\_shape\_aspect** for at least two **line\_termination\_connections**.

### 5.2.3.1.28 connector\_end\_type\_class

A **connector\_end\_type\_class** is a type of **group** that classifies the end type of the connectors that are assigned to it.

#### EXPRESS specification:

```

*)
ENTITY connector_end_type_class
  SUBTYPE OF (group);
END_ENTITY;
( *
```

### 5.2.3.1.29 descriptive\_colour

A **descriptive\_colour** is a type of **descriptive\_representation\_item** that identifies a colour.

#### EXPRESS specification:

```

*)
ENTITY descriptive_colour
  SUBTYPE OF (colour, descriptive_representation_item);
END_ENTITY;
( *
```

### 5.2.3.1.30 design\_project

A **design\_project** is a type of **organization** that identifies a task with a defined scope and purpose.

EXPRESS specification:

```

*)
ENTITY design_project
  SUBTYPE OF (organization);
WHERE
  WR1: SIZEOF (USEDIN (SELF, 'PLANT_SPATIAL_CONFIGURATION.' +
    'ORGANIZATION_ASSIGNMENT.ASSIGNED_ORGANIZATION')) >= 1;
END_ENTITY;
( *

```

Formal propositions:

**WR1:** Each **design\_project** shall be assigned to product data by at least one **organization\_assignment**.

### 5.2.3.1.31 design\_project\_assignment

A **design\_project\_assignment** assigns a **product\_definition** to a **design\_project**.

EXPRESS specification:

```

*)
ENTITY design_project_assignment
  SUBTYPE OF (organization_assignment);
  items : SET [1:?] OF design_project_item;
WHERE
  WR1: 'PLANT_SPATIAL_CONFIGURATION.DESIGN_PROJECT' IN
    TYPEOF (SELF.assigned_organization);
END_ENTITY;
( *

```

Attribute definitions:

**items:** the set of **product\_definitions** that are assigned to a **design\_project**.

Formal propositions:

**WR1:** The **organization** that is assigned by a **design\_project\_assignment** shall be a **design\_project**.

### 5.2.3.1.32 ducting\_system

A **ducting\_system** is a type of **product\_definition** that identifies a system that controls the temperature, humidity, cleanliness, and circulation of environmental air.

EXPRESS specification:

```

*)
ENTITY ducting_system
  SUBTYPE OF (product_definition);
WHERE
  WR1: SIZEOF (QUERY (pdr <* USEDIN (SELF, 'PLANT_SPATIAL_CONFIGURATION.' +
    'PRODUCT_DEFINITION_RELATIONSHIP.RELATED_PRODUCT_DEFINITION') |
    ('PLANT_SPATIAL_CONFIGURATION.PLANT' IN TYPEOF
    (pdr.relatng_product_definition.formation.of_product)) AND
    (pdr.relatng_product_definition.frame_of_reference.name =
    'functional occurrence')))) = 1;
END_ENTITY;
( *

```

Formal propositions:

**WR1:** The **ducting\_system** shall be related to exactly one **product\_definition** that is the definition of a plant and has a context of 'functional occurrence'.

### 5.2.3.1.33 elbow\_fitting\_class

An **elbow\_fitting\_class** is a type of group that classifies the items that are assigned to it as elbow fittings. The name of the **elbow\_fitting\_class** further classifies the assigned items.

EXPRESS specification:

```

*)
ENTITY elbow_fitting_class
  SUBTYPE OF (group);
WHERE
  WR1: SIZEOF (QUERY (aca <* QUERY (ca <* USEDIN (SELF,
    'PLANT_SPATIAL_CONFIGURATION.' +
    'CLASSIFICATION_ASSIGNMENT.ASSIGNED_CLASS') |
    'PLANT_SPATIAL_CONFIGURATION.APPLIED_CLASSIFICATION_ASSIGNMENT' IN
    TYPEOF (ca)) |
    NOT (SIZEOF (QUERY (it <* aca.items |
    NOT ('PLANT_SPATIAL_CONFIGURATION.PIPING_COMPONENT_DEFINITION' IN
    TYPEOF (it)))) = 0))) = 0;
  WR2: SIZEOF (QUERY (aca <* QUERY (ca <* USEDIN (SELF,
    'PLANT_SPATIAL_CONFIGURATION.CLASSIFICATION_ASSIGNMENT.' +
    'ASSIGNED_CLASS') |
    'PLANT_SPATIAL_CONFIGURATION.APPLIED_CLASSIFICATION_ASSIGNMENT' IN
    TYPEOF (ca)) |
    NOT (SIZEOF (QUERY (pcd <* QUERY (it <* aca.items |
    'PLANT_SPATIAL_CONFIGURATION.PIPING_COMPONENT_DEFINITION' IN
    TYPEOF (it)) |
    NOT (SIZEOF (QUERY (acal <* USEDIN (pcd.formation.of_product,
    'PLANT_SPATIAL_CONFIGURATION.' +
    'APPLIED_CLASSIFICATION_ASSIGNMENT.ITEMS') |
    class_in_tree (acal.assigned_class, 'elbow')) = 1))) = 0)))
    = 0;
END_ENTITY;
( *
```

Formal propositions:

**WR1:** An **elbow\_fitting\_class** shall classify items of type **pipng\_component\_definition**.

**WR2:** An **elbow\_fitting\_class** shall classify items of type **pipng\_component\_definition** that are a definition of a **product** that is classified as a 'elbow'.

### 5.2.3.1.34 electrical\_connector\_class

An **electrical\_connector\_class** is a type of **group** that classifies the items that are assigned to it as being electrical connectors. The name of the **electrical\_connector\_class** further classifies the assigned items.

EXPRESS specification:

```

*)
ENTITY electrical_connector_class
  SUBTYPE OF (group);
END_ENTITY;
( *
```

### 5.2.3.1.35 electrical\_system

An **electrical\_system** is a type of **product\_definition** that identifies a system of wiring, switches, relays and other equipment associated with receiving and distributing electrical power.

#### EXPRESS specification:

```
*)
ENTITY electrical_system
  SUBTYPE OF (product_definition);
WHERE
  WR1: SIZEOF (QUERY (pdr <* USEDIN (SELF, 'PLANT_SPATIAL_CONFIGURATION.' +
    'PRODUCT_DEFINITION_RELATIONSHIP.RELATED_PRODUCT_DEFINITION') |
    ('PLANT_SPATIAL_CONFIGURATION.PLANT' IN TYPEOF
    (pdr.relatng_product_definition.formation.of_product)) AND
    (pdr.relatng_product_definition.frame_of_reference.name =
    'functional occurrence')))) = 1;
END_ENTITY;
(*
```

#### Formal propositions:

**WR1:** The **electrical\_system** shall be related to exactly one **product\_definition** that is the definition of a plant and has a context of 'functional occurrence'.

### 5.2.3.1.36 externally\_defined\_class

An **externally\_defined\_class** is a type of **group** that classifies an item and is defined by reference to an external source.

**NOTE** An external source can be an ISO 13584 classification table [13]. This source should be specified as a **known\_source** (see 5.2.3.1.52) and referenced with **externally\_defined\_item.source**.

#### EXPRESS specification:

```
*)
ENTITY externally_defined_class
  SUBTYPE OF (group, externally_defined_item);
WHERE
  WR1: SIZEOF (QUERY (aca <* QUERY (ca <* USEDIN (SELF,
    'PLANT_SPATIAL_CONFIGURATION.CLASSIFICATION_ASSIGNMENT.' +
    'ASSIGNED_CLASS') |
    'PLANT_SPATIAL_CONFIGURATION.APPLIED_CLASSIFICATION_ASSIGNMENT' IN
    TYPEOF (ca)) |
    NOT (SIZEOF (QUERY (it <* aca.items |
    NOT ((SIZEOF (TYPEOF (it) *
    ['PLANT_SPATIAL_CONFIGURATION.ELECTRICAL_SYSTEM',
    'PLANT_SPATIAL_CONFIGURATION.DUCTING_SYSTEM',
    'PLANT_SPATIAL_CONFIGURATION.INSTRUMENTATION_AND_CONTROL_SYSTEM',
    'PLANT_SPATIAL_CONFIGURATION.PIPING_SYSTEM',
    'PLANT_SPATIAL_CONFIGURATION.PLANT',
    'PLANT_SPATIAL_CONFIGURATION.PLANT_ITEM_CONNECTOR',
    'PLANT_SPATIAL_CONFIGURATION.PIPING_COMPONENT_DEFINITION',
    'PLANT_SPATIAL_CONFIGURATION.STRUCTURAL_SYSTEM']) = 1) OR
    (('PLANT_SPATIAL_CONFIGURATION.PRODUCT_DEFINITION'
    IN TYPEOF (it)) AND
    (SIZEOF (QUERY (pc <*
    it.formation.of_product.frame_of_reference |
    pc.discipline_type = 'process plant')) = 1)))) = 0))) = 0;
END_ENTITY;
(*
```

Formal proposition:

**WR1:** An **externally\_defined\_class** shall classify either an **electrical\_system**, **ducting\_system**, **instrumentation\_and\_control\_system**, **piping\_system**, **plant**, **plant\_item\_connector**, **piping\_component\_definition**, **structural\_system**, or **product\_definition** that is the definition of a plant item.

Associated global rules:

The following global rules defined in this part of ISO 10303 apply to the **externally\_defined\_class** entity:

- **subtype\_mandatory\_externally\_defined\_item** (see 5.2.4.16);
- **subtype\_mandatory\_pre\_defined\_item** (see 5.2.4.17).

### 5.2.3.1.37 **externally\_defined\_document**

An **externally\_defined\_document** is a type of **document** that is defined by reference to an external source.

EXPRESS specification:

```
* )
ENTITY externally_defined_document
    SUBTYPE OF (document, externally_defined_item);
END_ENTITY;
( *
```

### 5.2.3.1.38 **externally\_defined\_plant\_item\_definition**

An **externally\_defined\_plant\_item\_definition** is a type of **product\_definition** that identifies an item or piece of equipment that may be used as a component of a plant and is defined by reference to an external source.

**NOTE** An external source can be a ISO 13584 library [13]. This source should be specified as a **known\_source** (see 5.2.3.1.52) and referenced with **externally\_defined\_item.source**.

EXPRESS specification:

```
* )
ENTITY externally_defined_plant_item_definition
    SUBTYPE OF (product_definition, externally_defined_item);
END_ENTITY;
( *
```

Associated global rules:

The following global rules defined in this part of ISO 10303 apply to the **externally\_defined\_plant\_item\_definition** entity:

- **application\_context\_requires\_ap\_definition** (see 5.2.4.1);
- **dependent\_instantiable\_application\_context** (see 5.2.4.9);
- **dependent\_instantiable\_product\_context** (see 5.2.4.10);

- **dependent\_instantiable\_product\_definition\_context** (see 5.2.4.11);
- **product\_context\_discipline\_type\_constraint** (see 5.2.4.12);
- **product\_definition\_context\_name\_constraint** (see 5.2.4.13);
- **subtype\_mandatory\_externally\_defined\_item** (see 5.2.4.16);
- **subtype\_mandatory\_pre\_defined\_item** (see 5.2.4.17).

### 5.2.3.1.39 externally\_defined\_representation\_item

An **externally\_defined\_representation\_item** is a type of **representation\_item** that has meaning defined in a source outside of this part of ISO 10303.

EXPRESS specification:

```
*)
ENTITY externally_defined_representation_item
  SUBTYPE OF (representation_item, externally_defined_item);
END_ENTITY;
( *
```

### 5.2.3.1.40 flange\_fitting\_class

A **flange\_fitting\_class** is a type of **group** that classifies the items that are assigned to it as flange fittings.

EXPRESS specification:

```
*)
ENTITY flange_fitting_class
  SUBTYPE OF (group);
WHERE
  WR1: SIZEOF (QUERY (aca <* QUERY (ca <* USEDIN (SELF,
    'PLANT_SPATIAL_CONFIGURATIONS.' +
    'CLASSIFICATION_ASSIGNMENT.ASSIGNED_CLASS') |
    'PLANT_SPATIAL_CONFIGURATIONS.APPLIED_CLASSIFICATION_ASSIGNMENT' IN
    TYPEOF (ca)) |
    NOT (SIZEOF (QUERY (it <* aca.items |
    NOT ('PLANT_SPATIAL_CONFIGURATIONS.PIPING_COMPONENT_DEFINITION' IN
    TYPEOF (it)))) = 0))) = 0;
  WR2: SIZEOF (QUERY (aca <* QUERY (ca <* USEDIN (SELF,
    'PLANT_SPATIAL_CONFIGURATIONS.' +
    'CLASSIFICATION_ASSIGNMENT.ASSIGNED_CLASS') |
    'PLANT_SPATIAL_CONFIGURATIONS.APPLIED_CLASSIFICATION_ASSIGNMENT' IN
    TYPEOF (ca)) |
    NOT (SIZEOF (QUERY (pcd <* QUERY (it <* aca.items |
    'PLANT_SPATIAL_CONFIGURATIONS.PIPING_COMPONENT_DEFINITION' IN
    TYPEOF (it)) |
    NOT (SIZEOF (QUERY (acal <* USEDIN (pcd.formation.of_product,
    'PLANT_SPATIAL_CONFIGURATIONS.' +
    'APPLIED_CLASSIFICATION_ASSIGNMENT.ITEMS') |
    class_in_tree (acal.assigned_class, 'flange')) = 1))) = 0))) = 0;
END_ENTITY;
( *
```

Formal propositions:

**WR1:** A **flange\_fitting\_class** shall classify items of type **pipings\_component\_definition**.

**WR2:** A **flange\_fitting\_class** shall classify items of type **pipng\_component\_definition** that are a definition of a **product** that is categorized as a 'flange'.

#### 5.2.3.1.41 flange\_fitting\_neck\_type\_class

A **flange\_fitting\_neck\_type\_class** is a type of **group** that classifies the neck type of the flange fittings items that are assigned to it.

##### EXPRESS specification:

```

*)
ENTITY flange_fitting_neck_type_class
  SUBTYPE OF (group);
WHERE
  WR1: SIZEOF (QUERY (aca <* QUERY (ca <* USEDIN (SELF,
    'PLANT_SPATIAL_CONFIGURATION.CLASSIFICATION_ASSIGNMENT.' +
    'ASSIGNED_CLASS') |
    'PLANT_SPATIAL_CONFIGURATION.APPLIED_CLASSIFICATION_ASSIGNMENT' IN
    TYPEOF (ca)) |
    NOT (SIZEOF (QUERY (it <* aca.items |
    NOT ('PLANT_SPATIAL_CONFIGURATION.PIPING_COMPONENT_DEFINITION' IN
    TYPEOF (it)))) = 0))) = 0;
  WR2: SIZEOF (QUERY (aca <* QUERY (ca <* USEDIN (SELF,
    'PLANT_SPATIAL_CONFIGURATION.CLASSIFICATION_ASSIGNMENT.' +
    'ASSIGNED_CLASS') |
    'PLANT_SPATIAL_CONFIGURATION.APPLIED_CLASSIFICATION_ASSIGNMENT' IN
    TYPEOF (ca)) |
    NOT (SIZEOF (QUERY (pcd <* QUERY (it <* aca.items |
    'PLANT_SPATIAL_CONFIGURATION.PIPING_COMPONENT_DEFINITION' IN
    TYPEOF (it)) |
    NOT (SIZEOF (QUERY (acal <* USEDIN (pcd.formation.of_product,
    'PLANT_SPATIAL_CONFIGURATION.' +
    'APPLIED_CLASSIFICATION_ASSIGNMENT.ITEMS') |
    class_in_tree (acal.applied_classification, 'flange'))
    = 1))) = 0))) = 0;
END_ENTITY;
( *
```

##### Formal propositions:

**WR1:** A **flange\_fitting\_neck\_type\_classification** shall classify items of type **pipng\_component\_definition**.

**WR2:** A **flange\_fitting\_neck\_type\_classification** shall classify items of type **pipng\_component\_definition** that are a definition of a **product** that is categorized as a 'flange'.

#### 5.2.3.1.42 heat\_tracing\_representation

A **heat\_tracing\_representation** is a type of **representation** that represents the means utilized to impart a temperature increase by an external wrapping or coiling.

##### EXPRESS specification:

```

*)
ENTITY heat_tracing_representation
  SUBTYPE OF (representation);
END_ENTITY;
( *
```

### 5.2.3.1.43 hvac\_branch\_connection

An **hvac\_branch\_connection** is a type of **shape\_aspect\_relationship** that identifies the connection between an HVAC section segment and a branch.

EXPRESS specification:

```
*)
ENTITY hvac_branch_connection
  SUBTYPE OF (shape_aspect_relationship);
WHERE
  WR1: SELF.description = 'branch location';
  WR2: 'PLANT_SPATIAL_CONFIGURATION.HVAC_SECTION_SEGMENT_DEFINITION'
    IN TYPEOF (SELF.relate_shape_aspect.of_shape.definition);
  WR3: 'PLANT_SPATIAL_CONFIGURATION.HVAC_SECTION_SEGMENT_TERMINATION'
    IN TYPEOF (SELF.related_shape_aspect);
END_ENTITY;
( *
```

Formal propositions:

**WR1:** The value of **hvac\_branch\_connection.description** shall be 'branch location'.

**WR2:** The **product\_definition** that the **relate\_shape\_aspect** of an **hvac\_branch\_connection** is related to shall be an **hvac\_section\_segment\_definition**.

**WR3:** The **related\_shape\_aspect** of an **hvac\_branch\_connection** shall be an **hvac\_section\_segment\_termination**.

### 5.2.3.1.44 hvac\_component\_definition

An **hvac\_component\_definition** is a type of **product\_definition** that defines an HVAC component.

EXPRESS specification

```
*)
ENTITY hvac_component_definition
  SUBTYPE OF (product_definition);
END_ENTITY;
( *
```

### 5.2.3.1.45 hvac\_connector

An **hvac\_connector** is a type of **shape\_aspect** that identifies a feature of a plant item that is designed to connect to another connector.

EXPRESS specification:

```
*)
ENTITY hvac_connector
  SUBTYPE OF (shape_aspect);
WHERE
  WR1: SELF\shape_aspect.of_shape\property_definition.
    definition\product_definition.
    frame_of_reference\application_context_element.name IN
    ['functional definition', 'physical definition',
    'functional occurrence', 'physical occurrence'];
  WR2: (NOT (SIZEOF (QUERY (pd <* USEDIN (SELF,
    'PLANT_SPATIAL_CONFIGURATION.PROPERTY_DEFINITION.DEFINITION') |
    pd.name = 'hvac service characteristics')) >= 1)) OR
```

```

        (sizeof (QUERY (sc <* QUERY (pd <* USEDIN (SELF,
        'PLANT_SPATIAL_CONFIGURATION.PROPERTY_DEFINITION.DEFINITION')) |
        pd.name = 'hvac service characteristics')) |
        NOT (sizeof (QUERY (pdr <* USEDIN (sc,
        'PLANT_SPATIAL_CONFIGURATION.' +
        'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION')) |
        pdr.used_representation.name =
        'design service characteristics')) = 1))) = 0));
WR3: (NOT (sizeof (QUERY (pd <* USEDIN (SELF,
        'PLANT_SPATIAL_CONFIGURATION.PROPERTY_DEFINITION.DEFINITION')) |
        (pd.name = 'hvac service characteristics')) >= 1)) OR
        (sizeof (QUERY (sc <* QUERY (pd <* USEDIN (SELF,
        'PLANT_SPATIAL_CONFIGURATION.PROPERTY_DEFINITION.DEFINITION')) |
        pd.name = 'hvac service characteristics')) |
        NOT (sizeof (QUERY (dsc <* QUERY (pdr <* USEDIN (sc,
        'PLANT_SPATIAL_CONFIGURATION.' +
        'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION')) |
        pdr.used_representation.name = 'design service characteristics')) |
        sizeof (dsc.used_representation.items) >= 2)) = 1))) = 0));
WR4: ((NOT (sizeof (QUERY (pd <* USEDIN (SELF,
        'PLANT_SPATIAL_CONFIGURATION.PROPERTY_DEFINITION.DEFINITION')) |
        pd.name = 'hvac service characteristics')) >= 1)) OR
        (sizeof (QUERY (sc <* QUERY (pd <* USEDIN (SELF,
        'PLANT_SPATIAL_CONFIGURATION.PROPERTY_DEFINITION.DEFINITION')) |
        pd.name = 'hvac service characteristics')) |
        NOT (sizeof (QUERY (dsc <* QUERY (pdr <* USEDIN (sc,
        'PLANT_SPATIAL_CONFIGURATION.' +
        'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION')) |
        pdr.used_representation.name = 'design service characteristics')) |
        {1 <= sizeof (QUERY (it <* dsc.used_representation.items |
        ('PLANT_SPATIAL_CONFIGURATION.MEASURE_REPRESENTATION_ITEM' IN
        typeof (it)) AND
        (it.name IN ['pressure', 'minimum pressure',
        'maximum pressure']))) <= 2}))) = 1))) = 0));
WR5: ((NOT (sizeof (QUERY (pd <* USEDIN (SELF,
        'PLANT_SPATIAL_CONFIGURATION.PROPERTY_DEFINITION.DEFINITION')) |
        pd.name = 'hvac service characteristics')) >= 1)) OR
        (sizeof (QUERY (sc <* QUERY (pd <* USEDIN (SELF,
        'PLANT_SPATIAL_CONFIGURATION.PROPERTY_DEFINITION.DEFINITION')) |
        pd.name = 'hvac service characteristics')) |
        NOT (sizeof (QUERY (dsc <* QUERY (pdr <* USEDIN (sc,
        'PLANT_SPATIAL_CONFIGURATION.' +
        'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION')) |
        pdr.used_representation.name = 'design service characteristics')) |
        sizeof (QUERY (it <* dsc.used_representation.items |
        ('PLANT_SPATIAL_CONFIGURATION.MEASURE_REPRESENTATION_ITEM' IN
        typeof (it)) AND
        (it.name = 'pressure')) <= 1)) = 1))) = 0));
WR6: ((NOT (sizeof (QUERY (pd <* USEDIN (SELF,
        'PLANT_SPATIAL_CONFIGURATION.PROPERTY_DEFINITION.DEFINITION')) |
        pd.name = 'hvac service characteristics')) >= 1)) OR
        (sizeof (QUERY (sc <* QUERY (pd <* USEDIN (SELF,
        'PLANT_SPATIAL_CONFIGURATION.PROPERTY_DEFINITION.DEFINITION')) |
        pd.name = 'hvac service characteristics')) |
        NOT (sizeof (QUERY (dsc <* QUERY (pdr <* USEDIN (sc,
        'PLANT_SPATIAL_CONFIGURATION.' +
        'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION')) |
        pdr.used_representation.name = 'design service characteristics')) |
        sizeof (QUERY (it <* dsc.used_representation.items |
        ('PLANT_SPATIAL_CONFIGURATION.MEASURE_REPRESENTATION_ITEM' IN
        typeof (it)) AND
        (it.name = 'minimum pressure')) <= 1)) = 1))) = 0));
WR7: ((NOT (sizeof (QUERY (pd <* USEDIN (SELF,
        'PLANT_SPATIAL_CONFIGURATION.PROPERTY_DEFINITION.DEFINITION')) |
        pd.name = 'hvac service characteristics')) >= 1)) OR
        (sizeof (QUERY (sc <* QUERY (pd <* USEDIN (SELF,
        'PLANT_SPATIAL_CONFIGURATION.PROPERTY_DEFINITION.DEFINITION')) |
        pd.name = 'hvac service characteristics')) |
        NOT (sizeof (QUERY (dsc <* QUERY (pdr <* USEDIN (sc,
        'PLANT_SPATIAL_CONFIGURATION.' +

```

```

'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') |
pdr.used_representation.name = 'design service characteristics') |
SIZEOF (QUERY (it <* dsc.used_representation.items |
('PLANT_SPATIAL_CONFIGURATION.MEASURE_REPRESENTATION_ITEM' IN
TYPEOF (it)) AND
(it.name = 'maximum pressure')) <= 1)) = 1))) = 0));
WR8: ((NOT (SIZEOF (QUERY (pd <* USEDIN (SELF,
'PLANT_SPATIAL_CONFIGURATION.PROPERTY_DEFINITION.DEFINITION') |
pd.name = 'hvac service characteristics')) >= 1)) OR
(SIZEOF (QUERY (sc <* QUERY (pd <* USEDIN (SELF,
'PLANT_SPATIAL_CONFIGURATION.PROPERTY_DEFINITION.DEFINITION') |
pd.name = 'hvac service characteristics') |
NOT (SIZEOF (QUERY (dsc <* QUERY (pdr <* USEDIN (sc,
'PLANT_SPATIAL_CONFIGURATION.' +
'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') |
pdr.used_representation.name = 'design service characteristics') |
{1 <= SIZEOF (QUERY (it <* dsc.used_representation.items |
(SIZEOF (TYPEOF (it) *
['PLANT_SPATIAL_CONFIGURATION.MEASURE_REPRESENTATION_ITEM',
'PLANT_SPATIAL_CONFIGURATION.' +
'THERMODYNAMIC_TEMPERATURE_MEASURE_WITH_UNIT']) = 2) AND
(it.name IN ['temperature', 'minimum temperature',
'maximum temperature']))) <= 2}))) = 1))) = 0));
WR9: ((NOT (SIZEOF (QUERY (pd <* USEDIN (SELF,
'PLANT_SPATIAL_CONFIGURATION.PROPERTY_DEFINITION.DEFINITION') |
pd.name = 'hvac service characteristics')) >= 1)) OR
(SIZEOF (QUERY (sc <* QUERY (pd <* USEDIN (SELF,
'PLANT_SPATIAL_CONFIGURATION.PROPERTY_DEFINITION.DEFINITION') |
pd.name = 'hvac service characteristics') |
NOT (SIZEOF (QUERY (dsc <* QUERY (pdr <* USEDIN (sc,
'PLANT_SPATIAL_CONFIGURATION.' +
'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') |
pdr.used_representation.name = 'design service characteristics') |
SIZEOF (QUERY (it <* dsc.used_representation.items |
(SIZEOF (TYPEOF (it) *
['PLANT_SPATIAL_CONFIGURATION.MEASURE_REPRESENTATION_ITEM',
'PLANT_SPATIAL_CONFIGURATION.' +
'THERMODYNAMIC_TEMPERATURE_MEASURE_WITH_UNIT']) = 2) AND
(it.name = 'temperature')) <= 1)) = 1))) = 0));
WR10: ((NOT (SIZEOF (QUERY (pd <* USEDIN (SELF,
'PLANT_SPATIAL_CONFIGURATION.PROPERTY_DEFINITION.DEFINITION') |
pd.name = 'hvac service characteristics')) >= 1)) OR
(SIZEOF (QUERY (sc <* QUERY (pd <* USEDIN (SELF,
'PLANT_SPATIAL_CONFIGURATION.PROPERTY_DEFINITION.DEFINITION') |
pd.name = 'hvac service characteristics') |
NOT (SIZEOF (QUERY (dsc <* QUERY (pdr <* USEDIN (sc,
'PLANT_SPATIAL_CONFIGURATION.' +
'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') |
pdr.used_representation.name = 'design service characteristics') |
SIZEOF (QUERY (it <* dsc.used_representation.items |
(SIZEOF (TYPEOF (it) *
['PLANT_SPATIAL_CONFIGURATION.MEASURE_REPRESENTATION_ITEM',
'PLANT_SPATIAL_CONFIGURATION.' +
'THERMODYNAMIC_TEMPERATURE_MEASURE_WITH_UNIT']) = 2) AND
(it.name = 'minimum temperature')) <= 1)) = 1))) = 0));
WR11: ((NOT (SIZEOF (QUERY (pd <* USEDIN (SELF,
'PLANT_SPATIAL_CONFIGURATION.PROPERTY_DEFINITION.DEFINITION') |
pd.name = 'hvac service characteristics')) >= 1)) OR
(SIZEOF (QUERY (sc <* QUERY (pd <* USEDIN (SELF,
'PLANT_SPATIAL_CONFIGURATION.PROPERTY_DEFINITION.DEFINITION') |
pd.name = 'hvac service characteristics') |
NOT (SIZEOF (QUERY (dsc <* QUERY (pdr <* USEDIN (sc,
'PLANT_SPATIAL_CONFIGURATION.' +
'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') |
pdr.used_representation.name = 'design service characteristics') |
SIZEOF (QUERY (it <* dsc.used_representation.items |
(SIZEOF (TYPEOF (it) *
['PLANT_SPATIAL_CONFIGURATION.MEASURE_REPRESENTATION_ITEM',
'PLANT_SPATIAL_CONFIGURATION.' +
'THERMODYNAMIC_TEMPERATURE_MEASURE_WITH_UNIT']) = 2) AND

```

```

        (it.name = 'maximum temperature')) <= 1)) = 1))) = 0));
WR12: (NOT (SELF\shape_aspect.of_shape\property_definition.
definition\product_definition.
frame_of_reference\application_context_element.name IN
['functional definition', 'functional occurrence'])) OR
(SIZEOF (QUERY (pdr <* USEDIN (SELF, 'PLANT_SPATIAL_CONFIGURATION.' +
'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') |
'PLANT_SPATIAL_CONFIGURATION.SHAPE_REPRESENTATION' IN
TYPEOF (pdr.used_representation))) = 0);
END_ENTITY;
( *

```

#### Formal propositions:

**WR1:** The **application\_context\_element** that applies to an **hvac\_connector** (as its **product\_definition\_context**) shall have the name 'functional occurrence'.

**WR2:** If the **hvac\_connector** has a **property\_definition** with a name of 'hvac service characteristics', the **property\_definition** shall have exactly one **representation** with the name of 'design service characteristics'.

**WR3:** If the **hvac\_connector** has a **property\_definition** with a name of 'hvac service characteristics', the **property\_definition** shall have exactly one **representation** with a name of 'design service characteristics' that has at least two **representation\_items**.

**WR4:** If the **hvac\_connector** has a **property\_definition** with a name of 'hvac service characteristics', the **property\_definition** shall have exactly one **representation** with a name of 'design service characteristics' that has one or two **representation\_items** of type **measure\_representation\_item** with a name of 'pressure', 'minimum pressure', or 'maximum pressure'.

**WR5:** If the **hvac\_connector** has a **property\_definition** with a name of 'hvac service characteristics', the **property\_definition** shall have exactly one **representation** with a name of 'design service characteristics' that has at most one **representation\_item** of type **measure\_representation\_item** with a name of 'pressure'.

**WR6:** If the **hvac\_connector** has a **property\_definition** with a name of 'hvac service characteristics', the **property\_definition** shall have exactly one **representation** with a name of 'design service characteristics' that has at most one **representation\_item** of type **measure\_representation\_item** with a name of 'minimum pressure'.

**WR7:** If the **hvac\_connector** has a **property\_definition** with a name of 'hvac service characteristics', the **property\_definition** shall have exactly one **representation** with a name of 'design service characteristics' that has at most one **representation\_item** of type **measure\_representation\_item** with a name of 'maximum pressure'.

**WR8:** If the **hvac\_connector** has a **property\_definition** with a name of 'hvac service characteristics', the **property\_definition** shall have exactly one **representation** with a name of 'design service characteristics' that has one or two **representation\_items** of type **measure\_representation\_item** and **thermodynamic\_temperature\_measure\_with\_unit** with a name of 'temperature', 'minimum temperature', or 'maximum temperature'.

**WR9:** If the **hvac\_connector** has a **property\_definition** with a **name** of 'hvac service characteristics', the **property\_definition** shall have exactly one **representation** with a **name** of 'design service characteristics' that has at most one **representation\_item** of type **measure\_representation\_item** and **thermodynamic\_temperature\_measure\_with\_unit** with a **name** of 'temperature'.

**WR10:** If the **hvac\_connector** has a **property\_definition** with a **name** of 'hvac service characteristics', the **property\_definition** shall have exactly one **representation** with a **name** of 'design service characteristics' that has at most one **representation\_item** of type **measure\_representation\_item** and **thermodynamic\_temperature\_measure\_with\_unit** with a **name** of 'minimum temperature'.

**WR11:** If the **hvac\_connector** has a **property\_definition** with a **name** of 'hvac service characteristics', the **property\_definition** shall have exactly one **representation** with a **name** of 'design service characteristics' that has at most one **representation\_item** of type **measure\_representation\_item** and **thermodynamic\_temperature\_measure\_with\_unit** with a **name** of 'maximum temperature'.

**WR12:** If an **hvac\_connector** is a type of functional connector it shall not have any **shape\_-representation**.

#### Associated global rules:

The following global rules defined in this part of ISO 10303 apply to the **plant\_item\_connector** entity:

- **application\_context\_requires\_ap\_definition** (see 5.2.4.1);
- **dependent\_instantiable\_application\_context** (see 5.2.4.9);
- **dependent\_instantiable\_product\_definition\_context** (see 5.2.4.11);
- **product\_definition\_context\_name\_constraint** (see 5.2.4.13);
- **product\_definition\_usage\_constraint** (see 5.2.4.14).

### 5.2.3.1.46 hvac\_cross\_section

An **hvac\_cross\_section** is a type of **shape\_aspect** that specifies the cross section of an HVAC connector.

#### EXPRESS specification:

```
*)
ENTITY hvac_cross_section
  SUBTYPE OF (shape_aspect);
END_ENTITY;
( *
```

### 5.2.3.1.47 hvac\_fitting\_class

An **hvac\_fitting\_class** is a type of **group** that classifies the items that are assigned to it as HVAC fittings.

#### EXPRESS specification:

```
*)
ENTITY hvac_fitting_class
  SUBTYPE OF (group);
WHERE
  WR1: SIZEOF (QUERY (aca <* QUERY (ca <* USEDIN (SELF,
    'PLANT_SPATIAL_CONFIGURATION.CLASSIFICATION_ASSIGNMENT.' +
    'ASSIGNED_CLASS') |
    'PLANT_SPATIAL_CONFIGURATION.APPLIED_CLASSIFICATION_ASSIGNMENT' IN
    TYPEOF (ca)) |
    NOT (SIZEOF (QUERY (it <* aca.items |
    NOT ('PLANT_SPATIAL_CONFIGURATION.HVAC_COMPONENT_DEFINITION' IN
    TYPEOF (it)))) = 0))) = 0);
```

```

WR2: SIZEOF (QUERY (aca <* QUERY (ca <* USEDIN (SELF,
'PLANT_SPATIAL_CONFIGURATION.CLASSIFICATION_ASSIGNMENT.' +
'ASSIGNED_CLASS') |
'PLANT_SPATIAL_CONFIGURATION.APPLIED_CLASSIFICATION_ASSIGNMENT' IN
TYPEOF (ca)) |
NOT (SIZEOF (QUERY (pcd <* QUERY (it <* aca.items |
'PLANT_SPATIAL_CONFIGURATION.HVAC_COMPONENT_DEFINITION' IN
TYPEOF (it)) |
NOT (SIZEOF (QUERY (acal <* USEDIN (pcd.formation.of_product,
'PLANT_SPATIAL_CONFIGURATION.' +
'APPLIED_CLASSIFICATION_ASSIGNMENT.ITEMS') |
class_in_tree (acal.assigned_class, 'hvac fitting'))
= 1))) = 0))) = 0;
END_ENTITY;
(*

```

#### Formal propositions:

**WR1:** An **hvac\_fitting\_class** shall classify items of type **hvac\_component\_definition**.

**WR2:** An **hvac\_fitting\_class** shall classify items of type **hvac\_component\_definition** that are a definition of a **product** that is categorized as a 'hvac fitting'.

### 5.2.3.1.48 hvac\_plant\_item\_branch\_connection

An **hvac\_plant\_item\_branch\_connection** is a type of **shape\_aspect\_relationship** that identifies the connection between an HVAC section segment and an hvac connector that branches from the segment.

#### EXPRESS specification:

```

*)
ENTITY hvac_plant_item_branch_connection
  SUBTYPE OF (shape_aspect_relationship);
WHERE
  WR1: SELF.description = 'branch location';
  WR2: 'PLANT_SPATIAL_CONFIGURATION.HVAC_SECTION_SEGMENT_DEFINITION'
    IN TYPEOF (SELF.relate_shape_aspect.of_shape.definition);
  WR3: 'PLANT_SPATIAL_CONFIGURATION.HVAC_CONNECTOR'
    IN TYPEOF (SELF.related_shape_aspect);
END_ENTITY;
(*

```

#### Formal propositions:

**WR1:** The value of **hvac\_plant\_item\_branch\_connection.description** shall be 'branch location'.

**WR2:** The **product\_definition** that the **relate\_shape\_aspect** of an **hvac\_plant\_item\_branch\_connection** is related to shall be an **hvac\_section\_segment\_definition**.

**WR3:** The **related\_shape\_aspect** of an **hvac\_branch\_connection** shall be an **hvac\_connector**.

### 5.2.3.1.49 hvac\_plant\_item\_connection

An **hvac\_plant\_item\_connection** is a type of **shape\_aspect\_relationship** that identifies the connection between an HVAC plant item termination and an HVAC connector.

#### EXPRESS specification:

```

*)
ENTITY hvac_plant_item_connection
  SUBTYPE OF (shape_aspect_relationship);

```

```

WHERE
  WR1: 'PLANT_SPATIAL_CONFIGURATION.HVAC_SECTION_SEGMENT_TERMINATION'
      IN TYPEOF (SELF.relate_shape_aspect);
  WR2: 'PLANT_SPATIAL_CONFIGURATION.HVAC_CONNECTOR'
      IN TYPEOF (SELF.relate_shape_aspect);
  WR3: SELF\shape_aspect_relationship.related_shape_aspect.
      of_shape\property_definition.
      definition\product_definition.
      frame_of_reference\application_context_element.
      name = 'physical occurrence';
END_ENTITY;
(*)

```

#### Formal propositions:

**WR1:** The **relate\_shape\_aspect** of an **hvac\_plant\_item\_connection** shall be an **hvac\_section\_segment\_termination**.

**WR2:** The **related\_shape\_aspect** of an **hvac\_plant\_item\_connection** shall be an **hvac\_connector**.

**WR3:** The **product\_definition** that the **related\_shape\_aspect** of an **hvac\_plant\_item\_connection** is related to shall have a context with the name 'physical occurrence'.

### 5.2.3.1.50 hvac\_section\_segment\_definition

An **hvac\_section\_segment\_definition** is a type of **product\_definition** that identifies an HVAC section segment.

#### EXPRESS specification:

```

*)
ENTITY hvac_section_segment_definition
  SUBTYPE OF (product_definition);
WHERE
  WR1: SIZEOF (QUERY (pdr <* USEDIN (SELF,
    'PLANT_SPATIAL_CONFIGURATION.' +
    'PRODUCT_DEFINITION_RELATIONSHIP.RELATED_PRODUCT_DEFINITION') |
    'PLANT_SPATIAL_CONFIGURATION.HVAC_SYSTEM_SECTION_DEFINITION'
    IN TYPEOF (pdr.relate_product_definition))) >= 1;
  WR2: SIZEOF (QUERY (pd <* USEDIN (SELF,
    'PLANT_SPATIAL_CONFIGURATION.PROPERTY_DEFINITION.DEFINITION') |
    'PLANT_SPATIAL_CONFIGURATION.SHAPE_DEFINITION' IN
    TYPEOF (pd))) >= 1;
  WR3: SELF.frame_of_reference\application_context_element.name =
    'functional definition';
  WR4: SIZEOF (QUERY (pdr <* USEDIN (SELF, 'PLANT_SPATIAL_CONFIGURATION.' +
    'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') |
    pdr.used_representation.name =
    'hvac section segment characteristics')) = 1;
  WR5: SIZEOF (QUERY (hssc <* QUERY (pdr <* USEDIN (SELF,
    'PLANT_SPATIAL_CONFIGURATION.' +
    'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') |
    pdr.used_representation.name =
    'hvac section segment characteristics') |
    NOT ({1 <= SIZEOF (QUERY (it <* hssc.used_representation.items |
    (it.name IN ['pressure drop',
    'maximum pressure drop', 'minimum pressure drop ']))} <= 2}))) = 0;
  WR6: SIZEOF (QUERY (hssc <* QUERY (pdr <* USEDIN (SELF,
    'PLANT_SPATIAL_CONFIGURATION.' +
    'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') |
    pdr.used_representation.name =
    'hvac section segment characteristics') |
    NOT (SIZEOF (QUERY (it <* hssc.used_representation.items |
    ('PLANT_SPATIAL_CONFIGURATION.MEASURE_REPRESENTATION_ITEM' IN
    TYPEOF (it)) AND

```

```

        (it.name = 'pressure drop')) <= 1))) = 0;
WR7: SIZEOF (QUERY (hssc <* QUERY (pdr <* USEDIN (SELF,
    'PLANT_SPATIAL_CONFIGURATION.' +
    'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') |
    pdr.used_representation.name =
    'hvac section segment characteristics') |
    NOT (SIZEOF (QUERY (it <* hssc.used_representation.items |
    ('PLANT_SPATIAL_CONFIGURATION.MEASURE_REPRESENTATION_ITEM' IN
    TYPEOF (it)) AND
    (it.name = 'minimum pressure drop')) <= 1))) = 0;
WR8: SIZEOF (QUERY (hssc <* QUERY (pdr <* USEDIN (SELF,
    'PLANT_SPATIAL_CONFIGURATION.' +
    'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') |
    pdr.used_representation.name =
    'hvac section segment characteristics') |
    NOT (SIZEOF (QUERY (it <* hssc.used_representation.items |
    ('PLANT_SPATIAL_CONFIGURATION.MEASURE_REPRESENTATION_ITEM' IN
    TYPEOF (it)) AND
    (it.name = 'maximum pressure drop')) <= 1))) = 0;
WR9: (NOT (SIZEOF (QUERY (pdr <* USEDIN (SELF,
    'PLANT_SPATIAL_CONFIGURATION.' +
    'PRODUCT_DEFINITION_RELATIONSHIP.RELATED_PRODUCT_DEFINITION') |
    pdr.name = 'hvac segment insulation')) >= 1)) OR
    (SIZEOF (QUERY (si <* QUERY (pdr <* USEDIN (SELF,
    'PLANT_SPATIAL_CONFIGURATION.' +
    'PRODUCT_DEFINITION_RELATIONSHIP.RELATED_PRODUCT_DEFINITION') |
    pdr.name = 'hvac segment insulation') |
    NOT (SIZEOF (QUERY (pd <* USEDIN (si,
    'PLANT_SPATIAL_CONFIGURATION.PROPERTY_DEFINITION.DEFINITION') |
    NOT (SIZEOF (QUERY (pds <* QUERY (pdr <* USEDIN (pd,
    'PLANT_SPATIAL_CONFIGURATION.' +
    'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') |
    'PLANT_SPATIAL_CONFIGURATION.PRODUCT_DEFINITION_SHAPE' IN
    TYPEOF (pdr)) |
    pds.used_representation.name =
    'hvac segment insulation characteristics')) = 1))) = 0))) = 0);
WR10: (NOT (SIZEOF (QUERY (pdr <* USEDIN (SELF,
    'PLANT_SPATIAL_CONFIGURATION.' +
    'PRODUCT_DEFINITION_RELATIONSHIP.RELATED_PRODUCT_DEFINITION') |
    pdr.name = 'hvac segment insulation')) >= 1)) OR
    (SIZEOF (QUERY (si <* QUERY (pdr <* USEDIN (SELF,
    'PLANT_SPATIAL_CONFIGURATION.' +
    'PRODUCT_DEFINITION_RELATIONSHIP.RELATED_PRODUCT_DEFINITION') |
    pdr.name = 'hvac segment insulation') |
    NOT (SIZEOF (QUERY (pd <* USEDIN (si,
    'PLANT_SPATIAL_CONFIGURATION.PROPERTY_DEFINITION.DEFINITION') |
    NOT (SIZEOF (QUERY (sic <* QUERY (pds <* QUERY (pdr <* USEDIN (pd,
    'PLANT_SPATIAL_CONFIGURATION.' +
    'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') |
    'PLANT_SPATIAL_CONFIGURATION.PRODUCT_DEFINITION_SHAPE' IN
    TYPEOF (pdr)) |
    pds.used_representation.name =
    'hvac segment insulation characteristics') |
    SIZEOF (sic.used_representation.items) >= 1)) = 1))) = 0))) = 0);
WR11: (NOT (SIZEOF (QUERY (pdr <* USEDIN (SELF,
    'PLANT_SPATIAL_CONFIGURATION.' +
    'PRODUCT_DEFINITION_RELATIONSHIP.RELATED_PRODUCT_DEFINITION') |
    pdr.name = 'hvac segment insulation')) >= 1)) OR
    (SIZEOF (QUERY (si <* QUERY (pdr <* USEDIN (SELF,
    'PLANT_SPATIAL_CONFIGURATION.' +
    'PRODUCT_DEFINITION_RELATIONSHIP.RELATED_PRODUCT_DEFINITION') |
    pdr.name = 'hvac segment insulation') |
    NOT (SIZEOF (QUERY (pd <* USEDIN (si,
    'PLANT_SPATIAL_CONFIGURATION.PROPERTY_DEFINITION.DEFINITION') |
    NOT (SIZEOF (QUERY (sic <* QUERY (pds <* QUERY (pdr <* USEDIN (pd,
    'PLANT_SPATIAL_CONFIGURATION.' +
    'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') |
    'PLANT_SPATIAL_CONFIGURATION.PRODUCT_DEFINITION_SHAPE' IN
    TYPEOF (pdr)) |
    pds.used_representation.name =

```

```

'hvac segment insulation characteristics') |
{1 <= SIZEOF (QUERY (it <* sic.used_representation.items |
(SIZEOF (TYPEOF (it) *
['PLANT_SPATIAL_CONFIGURATION.MEASURE_REPRESENTATION_ITEM',
'PLANT_SPATIAL_CONFIGURATION.LENGTH_MEASURE_WITH_UNIT']) = 2) AND
(it.name IN ['thickness', 'minimum thickness',
'maximum thickness']))) <= 2})) = 1))) = 0))) = 0);
WR12: (NOT (SIZEOF (QUERY (pdr <* USEDIN (SELF,
'PLANT_SPATIAL_CONFIGURATION.' +
'PRODUCT_DEFINITION_RELATIONSHIP.RELATED_PRODUCT_DEFINITION') |
pdr.name = 'hvac segment insulation')) >= 1)) OR
(SIZEOF (QUERY (si <* QUERY (pdr <* USEDIN (SELF,
'PLANT_SPATIAL_CONFIGURATION.' +
'PRODUCT_DEFINITION_RELATIONSHIP.RELATED_PRODUCT_DEFINITION') |
pdr.name = 'hvac segment insulation') |
NOT (SIZEOF (QUERY (pd <* USEDIN (si,
'PLANT_SPATIAL_CONFIGURATION.PROPERTY_DEFINITION.DEFINITION') |
NOT (SIZEOF (QUERY (sic <* QUERY (pds <* QUERY (pdr <* USEDIN (pd,
'PLANT_SPATIAL_CONFIGURATION.' +
'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') |
'PLANT_SPATIAL_CONFIGURATION.PRODUCT_DEFINITION_SHAPE' IN
TYPEOF (pdr)) |
pds.used_representation.name =
'segment insulation characteristics') |
SIZEOF (QUERY (it <* sic.used_representation.items |
(SIZEOF (TYPEOF (it) *
['PLANT_SPATIAL_CONFIGURATION.MEASURE_REPRESENTATION_ITEM',
'PLANT_SPATIAL_CONFIGURATION.LENGTH_MEASURE_WITH_UNIT']) = 2) AND
(it.name = 'thickness')))) <= 1)) = 1))) = 0))) = 0);
WR13: (NOT (SIZEOF (QUERY (pdr <* USEDIN (SELF,
'PLANT_SPATIAL_CONFIGURATION.' +
'PRODUCT_DEFINITION_RELATIONSHIP.RELATED_PRODUCT_DEFINITION') |
pdr.name = 'segment insulation')) >= 1)) OR
(SIZEOF (QUERY (si <* QUERY (pdr <* USEDIN (SELF,
'PLANT_SPATIAL_CONFIGURATION.' +
'PRODUCT_DEFINITION_RELATIONSHIP.RELATED_PRODUCT_DEFINITION') |
pdr.name = 'hvac segment insulation') |
NOT (SIZEOF (QUERY (pd <* USEDIN (si,
'PLANT_SPATIAL_CONFIGURATION.PROPERTY_DEFINITION.DEFINITION') |
NOT (SIZEOF (QUERY (sic <* QUERY (pds <* QUERY (pdr <* USEDIN (pd,
'PLANT_SPATIAL_CONFIGURATION.' +
'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') |
'PLANT_SPATIAL_CONFIGURATION.PRODUCT_DEFINITION_SHAPE' IN
TYPEOF (pdr)) |
pds.used_representation.name =
'hvac segment insulation characteristics') |
SIZEOF (QUERY (it <* sic.used_representation.items |
(SIZEOF (TYPEOF (it) *
['PLANT_SPATIAL_CONFIGURATION.MEASURE_REPRESENTATION_ITEM',
'PLANT_SPATIAL_CONFIGURATION.LENGTH_MEASURE_WITH_UNIT']) = 2) AND
(it.name = 'minimum thickness')))) <= 1)) = 1))) = 0))) = 0);
WR14: (NOT (SIZEOF (QUERY (pdr <* USEDIN (SELF,
'PLANT_SPATIAL_CONFIGURATION.' +
'PRODUCT_DEFINITION_RELATIONSHIP.RELATED_PRODUCT_DEFINITION') |
pdr.name = 'hvac segment insulation')) >= 1)) OR
(SIZEOF (QUERY (si <* QUERY (pdr <* USEDIN (SELF,
'PLANT_SPATIAL_CONFIGURATION.' +
'PRODUCT_DEFINITION_RELATIONSHIP.RELATED_PRODUCT_DEFINITION') |
pdr.name = 'hvac segment insulation') |
NOT (SIZEOF (QUERY (pd <* USEDIN (si,
'PLANT_SPATIAL_CONFIGURATION.PROPERTY_DEFINITION.DEFINITION') |
NOT (SIZEOF (QUERY (sic <* QUERY (pds <* QUERY (pdr <* USEDIN (pd,
'PLANT_SPATIAL_CONFIGURATION.' +
'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') |
'PLANT_SPATIAL_CONFIGURATION.PRODUCT_DEFINITION_SHAPE' IN
TYPEOF (pdr)) |
pds.used_representation.name =
'hvac segment insulation characteristics') |
SIZEOF (QUERY (it <* sic.used_representation.items |
(SIZEOF (TYPEOF (it) *

```

```

        [ 'PLANT_SPATIAL_CONFIGURATION.MEASURE_REPRESENTATION_ITEM',
          'PLANT_SPATIAL_CONFIGURATION.LENGTH_MEASURE_WITH_UNIT']] = 2) AND
        (it.name = 'maximum thickness')))) <= 1)) = 1))) = 0))) = 0);
WR15: SIZEOF (QUERY (pds <* QUERY (pd <* USEDIN (SELF,
        'PLANT_SPATIAL_CONFIGURATION.PROPERTY_DEFINITION.DEFINITION') |
        'PLANT_SPATIAL_CONFIGURATION.PRODUCT_DEFINITION_SHAPE' IN
        TYPEOF (pd)) |
        NOT (SIZEOF (QUERY (sa <*USEDIN (pds,
        'PLANT_SPATIAL_CONFIGURATION.SHAPE_ASPECT.OF_SHAPE') |
        'PLANT_SPATIAL_CONFIGURATION.HVAC_SECTION_SEGMENT_TERMINATION' IN
        TYPEOF (sa))) = 2))) = 0);
END_ENTITY;
( *

```

### Formal propositions:

**WR1:** An **hvac\_sectionsegment\_definition** shall be the **related\_product\_definition** in a **product\_definition\_relationship** that has a **relating\_product\_definition** that is an **hvac\_system\_section\_definition**.

**WR2:** An **hvac\_section\_segment\_definition** shall be referenced by a **shape\_definition**.

**WR3:** An **hvac\_section\_segment\_definition** shall have a **frame\_of\_reference** name of 'functional definition'.

**WR4:** An **hvac\_section\_segment\_definition** shall have exactly one representation with the name of 'hvac section segment characteristics'.

**WR5:** The representation of the **hvac\_section\_segment\_definition** with the name of 'hvac section segment characteristics' shall have between one and two **representation\_items** with a name of 'pressure drop', 'maximum pressure drop', or 'minimum pressure drop'.

**WR6:** The representation of the **hvac\_section\_segment\_definition** with the name of 'hvac section segment characteristics' shall have at most one **representation\_item** of type **measure\_representation\_item** with a name of 'pressure drop'.

**WR7:** The representation of the **hvac\_section\_segment\_definition** with the name of 'hvac section segment characteristics' shall have at most one **representation\_item** of type **measure\_representation\_item** with a name of 'minimum pressure drop'.

**WR8:** The representation of the **hvac\_section\_segment\_definition** with the name of 'hvac section segment characteristics' shall have at most one **representation\_item** of type **measure\_representation\_item** with a name of 'maximum pressure drop'.

**WR9** If the **hvac\_section\_segment\_definition** is related to a **product\_definition** as an 'hvac segment insulation', the **product\_definition** shall have a **product\_definition\_shape** that has exactly one **representation** with the **name** of 'hvac segment insulation characteristics'.

**WR10:** If the **hvac\_section\_segment\_definition** is related to a **product\_definition** as an 'hvac segment insulation', the **product\_definition** shall have a **product\_definition\_shape** that has exactly one **representation** with the **name** of 'hvac segment insulation characteristics' that has at least one **representation\_item**.

**WR11:** If the **hvac\_section\_segment\_definition** is related to a **product\_definition** as an 'hvac segment insulation', the **product\_definition** shall have a **product\_definition\_shape** that has exactly one **representation** with the **name** of 'hvac segment insulation characteristics' that has one or two **representation\_items** of type **measure\_representation\_item** and **length\_measure\_with\_unit** with a

**name** of 'thickness', 'minimum thickness', or 'maximum thickness'.

**WR12:** If the **hvac\_section\_segment\_definition** is related to a **product\_definition** as an 'hvac segment insulation', the **product\_definition** shall have a **product\_definition\_shape** that has exactly one **representation** with the **name** of 'hvac segment insulation characteristics' that has at most one **representation\_item** items of type **measure\_representation\_item** and **length\_measure\_with\_unit** with a **name** of 'thickness'.

**WR13:** If the **hvac\_section\_segment\_definition** is related to a **product\_definition** as an 'hvac segment insulation', the **product\_definition** shall have a **product\_definition\_shape** that has exactly one **representation** with the **name** of 'hvac segment insulation characteristics' that has at most one **representation\_item** items of type **measure\_representation\_item** and **length\_measure\_with\_unit** with a **name** of 'minimum thickness'.

**WR14:** If the **hvac\_section\_segment\_definition** is related to a **product\_definition** as an 'hvac segment insulation', the **product\_definition** shall have a **product\_definition\_shape** that has exactly one **representation** with the **name** of 'hvac segment insulation characteristics' that has at most one **representation\_item** items of type **measure\_representation\_item** and **length\_measure\_with\_unit** with a **name** of 'maximum thickness'.

**WR15:** The **hvac\_section\_segment\_definition** shall be related to exactly two instances of **hvac\_section\_segment\_termination**.

#### Associated global rules:

The following global rules defined in this part of ISO 10303 apply to the **hvac\_section\_segment\_definition** entity:

- **application\_context\_requires\_ap\_definition** (see 5.2.4.1);
- **dependent\_instantiable\_application\_context** (see 5.2.4.9);
- **dependent\_instantiable\_product\_definition\_context** (see 5.2.4.11);
- **product\_definition\_context\_name\_constraint** (see 5.2.4.13).

### 5.2.3.1.51 hvac\_section\_segment\_termination

An **hvac\_section\_segment\_termination** is a type of **shape\_aspect** that identifies the termination of an HVAC section segment.

#### EXPRESS specification:

```
*)
ENTITY hvac_section_segment_termination
  SUBTYPE OF (shape_aspect);
WHERE
  WR1: SIZEOF (QUERY (sar <*
    USEDIN (SELF, 'PLANT_SPATIAL_CONFIGURATION.' +
      'SHAPE_ASPECT_RELATIONSHIP.RELATING_SHAPE_ASPECT') +
    USEDIN (SELF, 'PLANT_SPATIAL_CONFIGURATION.' +
      'SHAPE_ASPECT_RELATIONSHIP.RELATED_SHAPE_ASPECT') ) |
    NOT (SIZEOF (TYPEOF (sar) *
      [ 'PLANT_SPATIAL_CONFIGURATION.HVAC_BRANCH_CONNECTION',
        'PLANT_SPATIAL_CONFIGURATION.HVAC_PLANT_ITEM_CONNECTION',
        'PLANT_SPATIAL_CONFIGURATION.HVAC_TERMINATION_CONNECTION' ] )
    = 1))) = 0;
```

```

WR2: SIZEOF (QUERY (sar <*
  USEDIN (SELF, 'PLANT_SPATIAL_CONFIGURATION.' +
    'SHAPE_ASPECT_RELATIONSHIP.RELATED_SHAPE_ASPECT') |
  SIZEOF (TYPEOF (sar) *
    ['PLANT_SPATIAL_CONFIGURATION.HVAC_BRANCH_CONNECTION',
    'PLANT_SPATIAL_CONFIGURATION.HVAC_PLANT_ITEM_CONNECTION']) = 1)) = 1;
END_ENTITY;
( *

```

#### Formal propositions:

**WR1:** An **hvac\_section\_segment\_termination** is the **relating\_shape\_aspect** or the **related\_shape\_aspect** in at least one **shape\_aspect\_relationship** that is an **hvac\_branch\_connection**, **hvac\_plant\_item\_connection**, or **hvac\_termination\_connection**.

**WR2:** An **hvac\_section\_segment\_termination** is the **related\_shape\_aspect** in exactly one **shape\_aspect\_relationship** that is an **hvac\_branch\_connection** or an **hvac\_plant\_item\_connection**.

#### Associated global rules:

The following global rules defined in this part of ISO 10303 apply to the **hvac\_section\_segment\_termination** entity:

- **application\_context\_requires\_ap\_definition** (see 5.2.4.1);
- **dependent\_instantiable\_application\_context** (see 5.2.4.9);
- **dependent\_instantiable\_product\_definition\_context** (see 5.2.4.11);
- **product\_definition\_context\_name\_constraint** (see 5.2.4.13).

### 5.2.3.1.52 hvac\_system

An **hvac\_system** is a type of **product\_definition** that identifies a system that is used for heating, ventilation, and air conditioning.

#### EXPRESS specification:

```

*)
ENTITY hvac_system
  SUBTYPE OF (product_definition);
WHERE
  WR1: SIZEOF (QUERY (pdr <* USEDIN (SELF, 'PLANT_SPATIAL_CONFIGURATION.' +
    'PRODUCT_DEFINITION_RELATIONSHIP.RELATED_PRODUCT_DEFINITION') |
    ('PLANT_SPATIAL_CONFIGURATION.PLANT' IN TYPEOF
    (pdr.relateing_product_definition.formation.of_product)) AND
    (pdr.relateing_product_definition.frame_of_reference.name =
    'functional occurrence')) = 1;
END_ENTITY;
( *

```

#### Formal propositions:

**WR1:** The **hvac\_system** shall be related to exactly one **product\_definition** that is the definition of a plant and has a context of 'functional occurrence'.

### 5.2.3.1.53 hvac\_system\_section\_definition

An **hvac\_system\_section\_definition** is a type of **product\_definition** that identifies an HVAC system section.

EXPRESS specification:

```

*)
ENTITY hvac_system_section_definition
  SUBTYPE OF (product_definition);
WHERE
  WR1: SIZEOF (QUERY (pdr <* USEDIN (SELF, 'PLANT_SPATIAL_CONFIGURATION.' +
    'PRODUCT_DEFINITION_RELATIONSHIP.RELATED_PRODUCT_DEFINITION') |
    ('PLANT_SPATIAL_CONFIGURATION.HVAC_SYSTEM' IN
    TYPEOF (pdr.relatng_product_definition)))) = 1;
  WR2: SIZEOF (QUERY (pdr <* USEDIN (SELF, 'PLANT_SPATIAL_CONFIGURATION.' +
    'PRODUCT_DEFINITION_RELATIONSHIP.RELATING_PRODUCT_DEFINITION') |
    'PLANT_SPATIAL_CONFIGURATION.HVAC_SECTION_SEGMENT_DEFINITION' IN
    TYPEOF (pdr.related_product_definition))) >= 1;
  WR3: SELF.frame_of_reference.name =
    'functional definition';
  WR4: SIZEOF (QUERY (pds <* QUERY (pd <* USEDIN (SELF,
    'PLANT_SPATIAL_CONFIGURATION.PROPERTY_DEFINITION.DEFINITION') |
    'PLANT_SPATIAL_CONFIGURATION.PRODUCT_DEFINITION_SHAPE' IN
    TYPEOF (pd)) |
    NOT (SIZEOF (QUERY (sa <*USEDIN (pds,
    'PLANT_SPATIAL_CONFIGURATION.SHAPE_ASPECT.OF_SHAPE') |
    ('PLANT_SPATIAL_CONFIGURATION.HVAC_SECTION_SEGMENT_TERMINATION' IN
    TYPEOF (sa)) AND
    (sa.description = 'hvac system section termination')))) <= 2))) = 0;
END_ENTITY;
( *

```

Formal propositions:

**WR1:** An **hvac\_system\_section\_definition** shall be related to exactly one **hvac\_system**.

**WR2:** An **hvac\_system\_section\_definition** shall be related to at least one **hvac\_section\_segment\_definition**.

**WR3:** An **hvac\_system\_section\_definition** shall have an **application\_context\_element.name** of 'functional definition'.

**WR4:** An **hvac\_system\_section\_definition** shall have at most two related instances of **hvac\_section\_segment\_termination** described as 'hvac system section termination'.

Associated global rules:

The following global rules defined in this part of ISO 10303 apply to the **hvac\_system\_section\_definition** entity:

- **application\_context\_requires\_ap\_definition** (see 5.2.4.1);
- **dependent\_instantiable\_application\_context** (see 5.2.4.9);
- **dependent\_instantiable\_product\_definition\_context** (see 5.2.4.11);
- **product\_definition\_context\_name\_constraint** (see 5.2.4.13).

### 5.2.3.1.54 hvac\_termination\_connection

An **hvac\_termination\_connection** is a type of **shape\_aspect\_relationship** that identifies a connection between two HVAC section segment terminations.

EXPRESS specification:

```
*)
ENTITY hvac_termination_connection
  SUBTYPE OF (shape_aspect_relationship);
WHERE
  WR1: 'PLANT_SPATIAL_CONFIGURATION.HVAC_SECTION_SEGMENT_TERMINATION'
    IN TYPEOF (SELF.relying_shape_aspect);
  WR2: 'PLANT_SPATIAL_CONFIGURATION.HVAC_SECTION_SEGMENT_TERMINATION'
    IN TYPEOF (SELF.related_shape_aspect);
END_ENTITY;
( *
```

Formal propositions:

**WR1:** The **relating\_shape\_aspect** of an **hvac\_termination\_connection** shall be a an **hvac\_section\_-segment\_termination**.

**WR2:** The **related\_shape\_aspect** of an **hvac\_termination\_connection** shall be a an **hvac\_section\_-segment\_termination**.

### 5.2.3.1.55 hybrid\_shape\_representation

A **hybrid\_shape\_representation** is a type of **shape\_representation** that is composed of CSG primitives, boolean operators, manifold solid boundary representation solids, shell based wireframe models, curves and surfaces.

EXPRESS specification:

```
*)
ENTITY hybrid_shape_representation
  SUBTYPE OF (shape_representation);
WHERE
  WR1: SIZEOF (QUERY (i <* SELF\representation.items |
    NOT (SIZEOF ([ 'PLANT_SPATIAL_CONFIGURATION.BOOLEAN_RESULT',
      'PLANT_SPATIAL_CONFIGURATION.CSG_SOLID',
      'PLANT_SPATIAL_CONFIGURATION.RECTANGULAR_PYRAMID',
      'PLANT_SPATIAL_CONFIGURATION.BLOCK',
      'PLANT_SPATIAL_CONFIGURATION.TORUS',
      'PLANT_SPATIAL_CONFIGURATION.RIGHT_CIRCULAR_CYLINDER',
      'PLANT_SPATIAL_CONFIGURATION.SPHERE',
      'PLANT_SPATIAL_CONFIGURATION.RIGHT_CIRCULAR_CONE',
      'PLANT_SPATIAL_CONFIGURATION.EXTRUDED_AREA_SOLID',
      'PLANT_SPATIAL_CONFIGURATION.REVOLVED_AREA_SOLID',
      'PLANT_SPATIAL_CONFIGURATION.AXIS2_PLACEMENT_3D',
      'PLANT_SPATIAL_CONFIGURATION.MANIFOLD_SOLID_BREP',
      'PLANT_SPATIAL_CONFIGURATION.SHELL_BASED_WIREFRAME_MODEL',
      'PLANT_SPATIAL_CONFIGURATION.CURVE',
      'PLANT_SPATIAL_CONFIGURATION.POINT',
      'PLANT_SPATIAL_CONFIGURATION.SURFACE',
      'PLANT_SPATIAL_CONFIGURATION.VECTOR',
      'PLANT_SPATIAL_CONFIGURATION.MEASURE_REPRESENTATION_ITEM',
      'PLANT_SPATIAL_CONFIGURATION.MAPPED_ITEM'] *
    TYPEOF(i)) = 1))) = 0;
  WR2: SIZEOF (QUERY (mi <* QUERY (item <* SELF\representation.items |
    'PLANT_SPATIAL_CONFIGURATION.MAPPED_ITEM' IN TYPEOF(item)) |
    NOT (SIZEOF ([ 'PLANT_SPATIAL_CONFIGURATION.' +
      'PLANT_CSG_SHAPE_REPRESENTATION',
```

```

        'PLANT_SPATIAL_CONFIGURATION.HYBRID_SHAPE_REPRESENTATION'] *
        TYPEOF(mi\mapped_item.mapping_source.mapped_representation))
        = 1))) = 0;
END_ENTITY;
( *

```

#### Formal propositions:

**WR1:** A **hybrid\_shape\_representation** shall contain **representation\_items** that are of type **boolean\_result**, **csg\_solid**, **rectangular\_pyramid**, **block**, **torus**, **right\_circular\_cylinder**, **sphere**, **right\_circular\_cone**, **extruded\_area\_solid**, **revolved\_area\_solid**, **shell\_based\_wireframe\_model**, **manifold\_solid\_brep**, **curve**, **point**, **surface**, **vector**, **axis2\_placement\_3d**, **measure\_representation\_item**, or **mapped\_item**.

**WR2:** If there is a **mapped\_item** in a **hybrid\_shape\_representation**, the source of the **mapped\_item** shall be a **plant\_csg\_shape\_representation** or a **hybrid\_shape\_representation**.

#### Associated global rule:

The following global rule defined in this part of ISO 10303 applies to the **hybrid\_shape\_representation** entity:

- **subtype\_mandatory\_shape\_representation** (see 5.2.4.18)

### 5.2.3.1.56 inline\_equipment

An **inline\_equipment** is a type of **piping\_component\_definition** that identifies an item that is inserted into the flow of a process stream.

#### EXPRESS specification:

```

*)
ENTITY inline_equipment
  SUBTYPE OF (piping_component_definition);
END_ENTITY;
( *

```

### 5.2.3.1.57 instrumentation\_and\_control\_system

An **instrumentation\_and\_control\_system** is a type of **product\_definition** that identifies a system of wiring, switches, controls, and other equipment associated with monitoring and controlling performance characteristics.

#### EXPRESS specification:

```

*)
ENTITY instrumentation_and_control_system
  SUBTYPE OF (product_definition);
WHERE
  WR1: SIZEOF (QUERY (pdr <* USEDIN (SELF, 'PLANT_SPATIAL_CONFIGURATION.' +
    'PRODUCT_DEFINITION_RELATIONSHIP.RELATED_PRODUCT_DEFINITION') |
    ('PLANT_SPATIAL_CONFIGURATION.PLANT' IN TYPEOF
    (pdr.relatng_product_definition.formation.of_product)) AND
    (pdr.relatng_product_definition.frame_of_reference.name =
    'functional occurrence')))) = 1;
END_ENTITY;
( *

```

Formal propositions:

**WR1:** The **instrumentation\_and\_control\_system** shall be related to exactly one **product\_definition** that is the definition of a plant and has a context of ‘functional occurrence’.

### 5.2.3.1.58 interfering\_shape\_element

An **interfering\_shape\_element** identifies a portion of the shape of an item that interferes with the shape of another item.

EXPRESS specification:

```
* )
ENTITY interfering_shape_element
  SUBTYPE OF (shape_aspect, shape_aspect_relationship);
END_ENTITY;
( *
```

### 5.2.3.1.59 known\_source

A **known\_source** is a type of **external\_source** whose identification is standardized for all implementations of this part of ISO 10303. The purpose of the **known\_source** entity data type is to identify particular sources of data that are used within the scope of this part of ISO 10303, and to associate specific data formats with such identification. The following known sources of data are identified in this part of ISO 10303:

- ISO 13584 Dictionaries, conforming to the requirements of ISO 13584-42. In this Part of ISO 10303, such Dictionaries are used to hold values of names for instances of **externally\_defined\_class**;
- ISO 13584 Parts Libraries, conforming to the requirements of ISO 13584-24. In this Part of ISO 10303, such Parts Libraries are used to hold collections of **catalogue\_connector** and **externally\_defined\_plant\_item\_definition**;

EXPRESS specification:

```
* )
ENTITY known_source
  SUBTYPE OF (external_source, pre_defined_item);
WHERE
  WR1: SELF\pre_defined_item.name IN
    ['ISO 13584 Dictionary', 'ISO 13584 Parts Library'];
END_ENTITY;
( *
```

Formal propositions:

**WR1:** The **name** of the **known\_source** inherited from the **pre\_defined\_item** shall be ‘ISO 13584 Dictionary’, or ‘ISO 13584 Parts Library’.

Attribute value definitions:

The **known\_source** shall be used as follows, based on the standard values of the name attribute.

**ISO 13584 Dictionary:** the **known\_source** shall be a dictionary as defined in ISO 13584-42. The string value given as the **item\_id** of an **externally\_defined\_item** that references this **known\_source** shall conform to the requirements for a Class\_BSU as defined in ISO 13584-42.

**ISO 13584 Parts Library:** the **known\_source** shall be a parts library as defined in ISO 13584-42. The string value given as the **item\_id** of an **externally\_defined\_item** that references this **known\_source** shall conform to the requirements for a BSU as defined in ISO 13584-42.

### 5.2.3.1.60 line\_branch\_connection

A **line\_branch\_connection** is a type of **shape\_aspect\_relationship** that identifies the connection between a line and a branch.

#### EXPRESS specification:

```
*)
ENTITY line_branch_connection
  SUBTYPE OF (shape_aspect_relationship);
WHERE
  WR1: SELF.description = 'branch location';
  WR2: 'PLANT_SPATIAL_CONFIGURATION.PLANT_LINE_SEGMENT_DEFINITION'
      IN TYPEOF (SELF.relate_shape_aspect.of_shape.definition);
  WR3: 'PLANT_SPATIAL_CONFIGURATION.PLANT_LINE_SEGMENT_TERMINATION'
      IN TYPEOF (SELF.related_shape_aspect);
END_ENTITY;
( *
```

#### Formal propositions:

**WR1:** The value of **line\_branch\_connection.description** shall be 'branch location'.

**WR2:** The **product\_definition** that the **relate\_shape\_aspect** of a **line\_branch\_connection** is related to shall be a **plant\_line\_segment\_definition**.

**WR3:** The **related\_shape\_aspect** of a **line\_branch\_connection** shall be a **plant\_line\_segment\_termination**.

### 5.2.3.1.61 line\_less\_piping\_system

A **line\_less\_piping\_system** is a type of **product\_definition** that identifies a piping system that is not part of a line.

#### EXPRESS specification:

```
*)
ENTITY line_less_piping_system
  SUBTYPE OF (product_definition);
END_ENTITY;
( *
```

### 5.2.3.1.62 line\_plant\_item\_branch\_connection

A **line\_plant\_item\_branch\_connection** is a type of **shape\_aspect\_relationship** that identifies the connection between a line and a plant item connector that branches from the line.

#### EXPRESS specification:

```
*)
ENTITY line_plant_item_branch_connection
  SUBTYPE OF (shape_aspect_relationship);
END_ENTITY;
( *
```

### 5.2.3.1.63 line\_plant\_item\_connection

A **line\_plant\_item\_connection** is a type of **shape\_aspect\_relationship** that identifies the connection between a line segment and a plant item connector.

#### EXPRESS specification:

```

*)
ENTITY line_plant_item_connection
  SUBTYPE OF (shape_aspect_relationship);
WHERE
  WR1: 'PLANT_SPATIAL_CONFIGURATION.PLANT_LINE_SEGMENT_TERMINATION'
    IN TYPEOF (SELF.relating_shape_aspect);
  WR2: 'PLANT_SPATIAL_CONFIGURATION.PLANT_ITEM_CONNECTOR'
    IN TYPEOF (SELF.related_shape_aspect);
  WR3: SELF\shape_aspect_relationship.related_shape_aspect.
    of_shape\property_definition.
    definition\product_definition.
    frame_of_reference\application_context_element.
    name = 'physical occurrence';
END_ENTITY;
( *
```

#### Formal propositions:

**WR1:** The **relating\_shape\_aspect** of a **line\_plant\_item\_connection** shall be a **plant\_line\_segment\_termination**.

**WR2:** The **related\_shape\_aspect** of a **line\_plant\_item\_connection** shall be a **plant\_item\_connector**.

**WR3:** The **product\_definition** that the **related\_shape\_aspect** of a **line\_plant\_item\_connection** is related to shall have a context with the name 'physical occurrence'.

### 5.2.3.1.64 line\_termination\_connection

A **line\_termination\_connection** is a type of **shape\_aspect\_relationship** that identifies a connection between two line segment terminations, or between a line segment termination and a connection node.

#### EXPRESS specification:

```

*)
ENTITY line_termination_connection
  SUBTYPE OF (shape_aspect_relationship);
WHERE
  WR1: SIZEOF (TYPEOF (SELF.relating_shape_aspect) *
    [ 'PLANT_SPATIAL_CONFIGURATION.CONNECTION_NODE',
      'PLANT_SPATIAL_CONFIGURATION.PLANT_LINE_SEGMENT_TERMINATION' ]
    ) >= 1;
  WR2: 'PLANT_SPATIAL_CONFIGURATION.PLANT_LINE_SEGMENT_TERMINATION'
    IN TYPEOF (SELF.related_shape_aspect);
END_ENTITY;
( *
```

#### Formal propositions:

**WR1:** The **relating\_shape\_aspect** of a **line\_termination\_connection** shall be a **connection\_node** or a **plant\_line\_segment\_termination**.

**WR2:** The **related\_shape\_aspect** of a **line\_termination\_connection** shall be a **plant\_line\_segment\_termination**.

termination.

### 5.2.3.1.65 pipe\_class

A **pipe\_class** is a type of **group** that classifies the items that are assigned to it as pipes. The name of the **pipe\_class** may further classify the assigned items.

EXPRESS specification:

```

*)
ENTITY pipe_class
  SUBTYPE OF (group);
WHERE
  WR1: SIZEOF (QUERY (aca <* QUERY (ca <* USEDIN (SELF,
    'PLANT_SPATIAL_CONFIGURATION.CLASSIFICATION_ASSIGNMENT.' +
    'ASSIGNED_CLASS') |
    'PLANT_SPATIAL_CONFIGURATION.APPLIED_CLASSIFICATION_ASSIGNMENT' IN
    TYPEOF (ca)) |
    NOT (SIZEOF (QUERY (it <* aca.items |
    NOT ('PLANT_SPATIAL_CONFIGURATION.PIPING_COMPONENT_DEFINITION' IN
    TYPEOF (it)))) = 0))) = 0;
  WR2: SIZEOF (QUERY (aca <* QUERY (ca <* USEDIN (SELF,
    'PLANT_SPATIAL_CONFIGURATION.CLASSIFICATION_ASSIGNMENT.' +
    'ASSIGNED_CLASS') |
    'PLANT_SPATIAL_CONFIGURATION.APPLIED_CLASSIFICATION_ASSIGNMENT' IN
    TYPEOF (ca)) |
    NOT (SIZEOF (QUERY (pcd <* QUERY (it <* aca.items |
    'PLANT_SPATIAL_CONFIGURATION.PIPING_COMPONENT_DEFINITION' IN
    TYPEOF (it)) |
    NOT (SIZEOF (QUERY (acal <* USEDIN (pcd.formation.of_product,
    'PLANT_SPATIAL_CONFIGURATION.' +
    'APPLIED_CLASSIFICATION_ASSIGNMENT.ITEMS') |
    class_in_tree (acal.assigned_class, 'pipe')) = 1))) = 0))) = 0;
END_ENTITY;
( *

```

Formal propositions:

**WR1:** A **pipe\_class** shall classify items of type **pipng\_component\_definition**.

**WR2:** A **pipe\_class** shall classify items of type **pipng\_component\_definition** that are a definition of a **product** that is categorized as a 'pipe'.

### 5.2.3.1.66 pipe\_closure\_fitting\_class

A **pipe\_closure\_fitting\_class** is a type of **group** that classifies the items that are assigned to it as pipe closure fittings. The name of the **pipe\_closure\_fitting\_class** may further classify the assigned items.

EXPRESS specification:

```

*)
ENTITY pipe_closure_fitting_class
  SUBTYPE OF (group);
WHERE
  WR1: SIZEOF (QUERY (aca <* QUERY (ca <* USEDIN (SELF,
    'PLANT_SPATIAL_CONFIGURATION.CLASSIFICATION_ASSIGNMENT.' +
    'ASSIGNED_CLASS') |
    'PLANT_SPATIAL_CONFIGURATION.APPLIED_CLASSIFICATION_ASSIGNMENT' IN
    TYPEOF (ca)) |
    NOT (SIZEOF (QUERY (it <* aca.items |
    NOT ('PLANT_SPATIAL_CONFIGURATION.PIPING_COMPONENT_DEFINITION' IN
    TYPEOF (it)))) = 0))) = 0;

```

```

WR2: SIZEOF (QUERY (aca <* QUERY (ca <* USEDIN (SELF,
'PLANT_SPATIAL_CONFIGURATION.CLASSIFICATION_ASSIGNMENT.' +
'ASSIGNED_CLASS') |
'PLANT_SPATIAL_CONFIGURATION.APPLIED_CLASSIFICATION_ASSIGNMENT' IN
TYPEOF (ca)) |
NOT (SIZEOF (QUERY (pcd <* QUERY (it <* aca.items |
'PLANT_SPATIAL_CONFIGURATION.PIPING_COMPONENT_DEFINITION' IN
TYPEOF (it)) |
NOT (SIZEOF (QUERY (acal <* USEDIN (pcd.formation.of_product,
'PLANT_SPATIAL_CONFIGURATION.' +
'APPLIED_CLASSIFICATION_ASSIGNMENT.ITEMS') |
class_in_tree (acal.assigned_class, 'pipe closure'))
= 1))) = 0))) = 0;
END_ENTITY;
(*

```

#### Formal propositions:

**WR1:** A **pipe\_closure\_fitting\_class** shall classify items of type **pipng\_component\_definition**.

**WR2:** A **pipe\_closure\_fitting\_class** shall classify items of type **pipng\_component\_definition** that are a definition of a **product** that is categorized as a 'pipe closure'.

### 5.2.3.1.67 **pipng\_component\_class**

A **pipng\_component\_class** is a type of **group** that is a **characterized\_object** representing a family of piping components defined by parameter range values.

#### EXPRESS specification:

```

*)
ENTITY pipng_component_class
  SUBTYPE OF (group, characterized_object);
END_ENTITY;
(*

```

#### Associated global rule:

The following global rule defined in this part of ISO 10303 applies to the **pipng\_component\_class** entity:

- **subtype\_exclusive\_characterized\_object** (see 5.2.4.15)

### 5.2.3.1.68 **pipng\_component\_definition**

A **pipng\_component\_definition** is a type of **product\_definition** that defines a piping component.

#### EXPRESS specification:

```

*)
ENTITY pipng_component_definition
  SUBTYPE OF (product_definition);
END_ENTITY;
(*

```

### 5.2.3.1.69 **pipng\_connector\_class**

A **pipng\_connector\_class** is a type of **group** that classifies the items that are assigned to it as being

piping connectors.

#### EXPRESS specification:

```
*)
ENTITY piping_connector_class
  SUBTYPE OF (group);
END_ENTITY;
( *
```

### 5.2.3.1.70 piping\_spool\_definition

A **piping\_spool\_definition** is a type of **product\_definition** that defines an assembly of **piping - components** and other **plant\_items** to be fabricated in a shop and physically connected into one item.

NOTE Only welded or screwed **piping\_components** are included in a spool piece

```
*)
ENTITY piping_spool_definition
  SUBTYPE OF (product_definition);
WHERE
  WR1: SIZEOF (USEDIN (SELF, 'PLANT_SPATIAL_CONFIGURATION.' +
    'PRODUCT_DEFINITION_RELATIONSHIP.RELATING_PRODUCT_DEFINITION')) > 1;
END_ENTITY;
( *
```

#### Formal propositions:

WR1: The **piping\_spool\_definition** shall relate more than **product\_definition**.

### 5.2.3.1.71 piping\_support\_definition

A **piping\_support\_definition** is a type of **product\_definition** that defines a piping support.

#### EXPRESS specification

```
*)
ENTITY piping_support_definition
  SUBTYPE OF (product_definition);
END_ENTITY;
( *
```

### 5.2.3.1.72 piping\_support\_fitting\_class

A **piping\_support\_fitting\_class** is a type of **group** that classifies the items that are assigned to it as piping support fittings. The name of the **piping\_support\_fitting\_class** may further classify the assigned items.

#### EXPRESS specification:

```
*)
ENTITY piping_support_fitting_class
  SUBTYPE OF (group);
WHERE
  WR1: SIZEOF (QUERY (aca <* QUERY (ca <* USEDIN (SELF,
    'PLANT_SPATIAL_CONFIGURATION.CLASSIFICATION_ASSIGNMENT.' +
    'ASSIGNED_CLASS') |
    'PLANT_SPATIAL_CONFIGURATION.APPLIED_CLASSIFICATION_ASSIGNMENT' IN
    TYPEOF (ca)) |
    NOT (SIZEOF (QUERY (it <* aca.items |
```

```

        NOT ('PLANT_SPATIAL_CONFIGURATION.PIPING_SUPPORT_DEFINITION' IN
        TYPEOF (it)))) = 0))) = 0;
WR2: SIZEOF (QUERY (aca <* QUERY (ca <* USEDIN (SELF,
'PLANT_SPATIAL_CONFIGURATION.CLASSIFICATION_ASSIGNMENT.' +
'ASSIGNED_CLASS') |
'PLANT_SPATIAL_CONFIGURATION.APPLIED_CLASSIFICATION_ASSIGNMENT' IN
TYPEOF (ca)) |
NOT (SIZEOF (QUERY (pcd <* QUERY (it <* aca.items |
'PLANT_SPATIAL_CONFIGURATION.PIPING_COMPONENT_DEFINITION' IN
TYPEOF (it)) |
NOT (SIZEOF (QUERY (acal <* USEDIN (pcd.formation.of_product,
'PLANT_SPATIAL_CONFIGURATION.' +
'APPLIED_CLASSIFICATION_ASSIGNMENT.ITEMS') |
class_in_tree (acal.assigned_class, 'piping support'))
= 1))) = 0))) = 0;
END_ENTITY;
( *

```

#### Formal propositions:

**WR1:** A **piping\_support\_fitting\_class** shall classify items of type **piping\_component\_definition**.

**WR2:** A **piping\_support\_fitting\_class** shall classify items of type **piping\_component\_definition** that are a definition of a **product** that is categorized as a 'piping support'.

### 5.2.3.1.73 **piping\_system**

A **piping\_system** is a type of **product\_definition** that identifies a system of interconnected objects that convey fluid, vapour, or particulate flow.

#### EXPRESS specification:

```

*)
ENTITY piping_system
  SUBTYPE OF (product_definition);
WHERE
  WR1: SIZEOF (QUERY (pdr <* USEDIN (SELF, 'PLANT_SPATIAL_CONFIGURATION.' +
'PRODUCT_DEFINITION_RELATIONSHIP.RELATED_PRODUCT_DEFINITION') |
('PLANT_SPATIAL_CONFIGURATION.PLANT' IN TYPEOF
(pdr.relatng_product_definition.formation.of_product)) AND
(pdr.relatng_product_definition.frame_of_reference.name =
'functional occurrence')) = 1;
END_ENTITY;
( *

```

#### Formal propositions:

**WR1:** The **piping\_system** shall be related to exactly one **product\_definition** that is the definition of a plant and has a context of 'functional occurrence'.

### 5.2.3.1.74 **plant**

A **plant** is a type of **product** that identifies a process plant facility.

#### EXPRESS specification:

```

*)
ENTITY plant
  SUBTYPE OF (product);
WHERE
  WR1: SIZEOF (QUERY (pscoa <* USEDIN (SELF,
'PLANT_SPATIAL_CONFIGURATION.' +

```

```

        'PLANT_SPATIAL_CONFIGURATION_ORGANIZATION_ASSIGNMENT.ITEMS') |
pscoa.role.name =
'plant operator')) +
SIZEOF (QUERY (pscpaoa <* USEDIN (SELF,
'PLANT_SPATIAL_CONFIGURATION.' +
'PLANT_SPATIAL_CONFIGURATION_PERSON_AND_ORGANIZATION_ASSIGNMENT.' +
'ITEMS') |
pscpaoa.role.name =
'plant operator')) <= 1;
WR2: SIZEOF (QUERY (pscoa <* USEDIN (SELF,
'PLANT_SPATIAL_CONFIGURATION.' +
'PLANT_SPATIAL_CONFIGURATION_ORGANIZATION_ASSIGNMENT.ITEMS') |
pscoa.role.name = 'plant owner')) +
SIZEOF (QUERY (pscpaoa <* USEDIN (SELF,
'PLANT_SPATIAL_CONFIGURATION.' +
'PLANT_SPATIAL_CONFIGURATION_PERSON_AND_ORGANIZATION_ASSIGNMENT.' +
'ITEMS') |
pscpaoa.role.name =
'plant owner')) +
SIZEOF (QUERY (pscpa <* USEDIN (SELF,
'PLANT_SPATIAL_CONFIGURATION.' +
'PLANT_SPATIAL_CONFIGURATION_PERSON_ASSIGNMENT.ITEMS') |
pscpa.role.name = 'plant owner')) >= 1;
WR3: SIZEOF (QUERY (pscoa <* USEDIN (SELF,
'PLANT_SPATIAL_CONFIGURATION.' +
'PLANT_SPATIAL_CONFIGURATION_ORGANIZATION_ASSIGNMENT.ITEMS') |
pscoa\organization_assignment.role.name =
'plant project owner')) +
SIZEOF (QUERY (pscpaoa <* USEDIN (SELF,
'PLANT_SPATIAL_CONFIGURATION.' +
'PLANT_SPATIAL_CONFIGURATION_PERSON_AND_ORGANIZATION_ASSIGNMENT.' +
'ITEMS') |
pscpaoa\person_and_organization_assignment.role.name =
'plant project owner')) >= 1;
WR4: SIZEOF (QUERY (pdf <* USEDIN (SELF,
'PLANT_SPATIAL_CONFIGURATION.' +
'PRODUCT_DEFINITION_FORMATION.OF_PRODUCT') |
NOT (SIZEOF (QUERY (pd <* USEDIN (pdf,
'PLANT_SPATIAL_CONFIGURATION.PRODUCT_DEFINITION.FORMATION') |
pd.frame_of_reference.name = 'functional occurrence')) <= 1))) = 0;
END_ENTITY;
(*

```

#### Formal propositions:

**WR1:** A **plant** is associated with zero or one **person\_and\_organization** or **organization** in the role of plant operator.

**WR2:** A **plant** is associated with at least one **organization**, **person\_and\_organization**, or **person** in the role of plant owner.

**WR3:** A **plant** is associated with at least one **person\_and\_organization** or **organization** in the role of plant project owner.

**WR4:** A **plant** shall be related to at most one **product\_definition** that has a context of 'functional occurrence'.

#### Informal proposition:

**IP1:** If the **plant** has shape, then the **shape\_representation** depicting that shape shall have exactly one **axis2\_placement\_3d** instance in its items set with a name of 'origin'.

#### Associated global rules:

The following global rules defined in this part of ISO 10303 apply to the **plant** entity:

- **application\_context\_requires\_ap\_definition** (see 5.2.4.1);
- **dependent\_instantiable\_application\_context** (see 5.2.4.9);
- **dependent\_instantiable\_product\_context** (see 5.2.4.10);
- **product\_context\_discipline\_type\_constraint** (see 5.2.4.12).

### 5.2.3.1.75 **plant\_csg\_shape\_representation**

A **plant\_csg\_shape\_representation** is a type of **shape\_representation** that is composed of CSG primitives, revolved solids, extruded solids, and boolean operators.

EXPRESS specification:

```
*)
ENTITY plant_csg_shape_representation
  SUBTYPE OF (shape_representation);
WHERE
  WR1: SIZEOF (QUERY (item <* SELF.items |
    NOT (SIZEOF ([ 'PLANT_SPATIAL_CONFIGURATION.CSG_SOLID',
      'PLANT_SPATIAL_CONFIGURATION.EXTRUDED_AREA_SOLID',
      'PLANT_SPATIAL_CONFIGURATION.REVOLVED_AREA_SOLID',
      'PLANT_SPATIAL_CONFIGURATION.AXIS2_PLACEMENT_3D',
      'PLANT_SPATIAL_CONFIGURATION.MAPPED_ITEM'] * TYPEOF (item)) = 1)))
    = 0;
  WR2: SIZEOF (QUERY (item <* SELF.items |
    SIZEOF ([ 'PLANT_SPATIAL_CONFIGURATION.CSG_SOLID',
      'PLANT_SPATIAL_CONFIGURATION.EXTRUDED_AREA_SOLID',
      'PLANT_SPATIAL_CONFIGURATION.REVOLVED_AREA_SOLID',
      'PLANT_SPATIAL_CONFIGURATION.MAPPED_ITEM'] * TYPEOF (item))
    = 1)) >= 1;
  WR3: SIZEOF (QUERY (item <* SELF.items |
    ('PLANT_SPATIAL_CONFIGURATION.CSG_SOLID' IN TYPEOF (item)) AND
    (NOT (valid_advanced_csg_tree
      (item\csg_solid.tree_root_expression))))) = 0;
  WR4: SIZEOF (QUERY (mi <* QUERY (item <* SELF.items |
    'PLANT_SPATIAL_CONFIGURATION.MAPPED_ITEM' IN TYPEOF (item)) |
    NOT ('PLANT_SPATIAL_CONFIGURATION.' +
      'PLANT_CSG_SHAPE_REPRESENTATION' IN
      TYPEOF (mi\mapped_item.mapping_source.mapped_representation)))) = 0;
END_ENTITY;
(*
```

Formal propositions:

**WR1:** Each item of a **plant\_csg\_shape\_representation** shall be a **csg\_solid**, **extruded\_area\_solid**, **revolved\_area\_solid**, **axis2\_placement\_3d**, or **mapped\_item**.

**WR2:** A **plant\_csg\_shape\_representation** shall have at least one **representation\_item** instance in its set of items that is of type **csg\_solid**, **extruded\_area\_solid**, **revolved\_area\_solid**, or **mapped\_item**.

**WR3:** A **plant\_csg\_shape\_representation** shall be comprised of the proper CSG tree elements.

**WR4:** For each **mapped\_item** in a **plant\_csg\_shape\_representation**, the source of the **mapped\_item** shall be a **plant\_csg\_shape\_representation**.

Associated global rule:

The following global rule defined in this part of ISO 10303 applies to the **plant\_csg\_shape\_representation** entity:

- **subtype\_mandatory\_shape\_representation** (see 5.2.4.18)

### 5.2.3.1.76 **plant\_design\_csg\_primitive**

A **plant\_design\_csg\_primitive** is a type of **solid\_model** and a **shape\_representation** which specifies a parameterised definition of a constructive solid geometry primitive that is specific to plant design.

NOTE The **plant\_design\_csg\_primitive** is necessary in this part of ISO 10303 to facilitate the representation of CSG primitives specific to plant design CAD systems that were not acceptable as generic CSG primitives within ISO 10303-42.

A **plant\_design\_csg\_primitive** represents one of the following types of CSG primitives specific to plant design:

- hemisphere;
- rectangle to ellipse;
- trimmed sphere;
- trimmed pyramid.

Each type of csg primitive has specific parameters defined for it. The parameters and their requirements are defined in the following clauses.

#### 5.2.3.1.76.1 hemisphere

The hemisphere is a **plant\_design\_csg\_primitive** with a name of 'hemisphere'. It has two parameters: position and radius. The position is defined by an **axis2\_placement\_3d**. The location attribute of the position specifies the center of the circle formed by the center cut through the sphere upon which the hemisphere is based. The orientation consists of an x,y plane and a z direction. The xy plane specifies the plane in which the center cut circle is defined. The location point shall lie in the xy plane. The z axis direction specifies the direction from the center point which the volume occupies. The radius is defined by a **measure\_representation\_item** that is also a **length\_measure\_with\_unit**. It specifies the radius of the sphere upon which the hemisphere is based.

#### 5.2.3.1.76.2 rectangle to ellipse

The rectangle to ellipse is a **plant\_design\_csg\_primitive** with a name of 'rectangle to ellipse'. It has eight parameters: position, x size, y size, height, x offset, y offset, semi axis 1, and semi axis 2. The volume is defined by forming transition surfaces between the rectangle defined by x size and y size and the ellipse defined by the semi axis 1 and semi axis 2. The length of the transition is defined by the height. The rectangle to ellipse may be skewed if the x offset or y offset have non-zero values. The base of the volume is a rectangle with its center at the location point of the position. The size of the rectangle is defined by the parameters x size along the X axis and y size along the Y axis. The ellipse is in the plane perpendicular to the Z axis at distance height in the positive Z direction. The center of the ellipse is at x offset, y offset from the intersection point of the Z axis defined by the position and that plane.

The major axis of the ellipse is parallel to the X axis defined by the position, and the minor axis is

parallel to the Y axis defined by the position.

#### 5.2.3.1.76.3 trimmed sphere

The trimmed sphere is a **plant\_design\_csg\_primitive** with a name of 'trimmed sphere'. It has two parameters: sphere, direction and height. The height varies from -radius to +radius. To place the cutting plane, locate a point along the vector defined by the direction with magnitude of the absolute value of the height coming out of center of the sphere. A cutting plane passes through this point and is perpendicular to the direction. A positive value for the height indicates a trim of the section above the cutting plane. A negative value for the height indicates a trim of the section below the cutting plane.

#### 5.2.3.1.76.4 trimmed pyramid

The trimmed pyramid is a **plant\_design\_csg\_primitive** with a name of 'trimmed pyramid'. It defines a shape that is a rectangular pyramid that may be skewed. It has eight parameters that define a top and a bottom face, and a height: base position, base length, base width, height, top center x, top center y, top length and top width. The base position is and axis2\_placement\_3d. The base length and base width define the rectangle that comprises the base of the pyramid with the location point of the base position at the center of the rectangle. The height defines the distance along the z axis at which to place the plane in which the top face of the pyramid is defined. The top center x and top center y parameters define the distance from the point formed by the intersection of the top plane and the z axis of the position at which to place the center of the top face. The top length and top width define the boundaries of the top face of the pyramid.

#### EXPRESS specification:

```

*)
ENTITY plant_design_csg_primitive
  SUBTYPE OF (shape_representation, solid_model);
WHERE
  WR1: SELF.context_of_items.coordinate_space_dimension = 3;
  WR2: SELF\representation.name = SELF\representation_item.name;
  WR3: SELF\representation.name IN ['hemisphere', 'rectangle to ellipse',
    'trimmed sphere', 'trimmed pyramid'];
  WR4: (NOT (SELF\representation.name = 'hemisphere')) OR
    (SIZEOF (SELF.items) = 2);
  WR5: (NOT (SELF\representation.name = 'hemisphere')) OR
    (SIZEOF (QUERY (it <* SELF.items |
      (it.name = 'position') AND
      ('PLANT_SPATIAL_CONFIGURATION.AXIS2_PLACEMENT_3D' IN
        TYPEOF (it)))) = 1);
  WR6: (NOT (SELF\representation.name = 'hemisphere')) OR
    (SIZEOF (QUERY (it <* SELF.items |
      (it.name = 'radius') AND
      (SIZEOF (['PLANT_SPATIAL_CONFIGURATION.MEASURE_REPRESENTATION_ITEM',
        'PLANT_SPATIAL_CONFIGURATION.LENGTH_MEASURE_WITH_UNIT'] *
        TYPEOF (it)) = 2))) = 1);
  WR7: (NOT (SELF\representation.name = 'rectangle to ellipse')) OR
    (SIZEOF (SELF.items) = 8);
  WR8: (NOT (SELF\representation.name = 'rectangle to ellipse')) OR
    (SIZEOF (QUERY (it <* SELF.items |
      (it.name = 'position') AND
      ('PLANT_SPATIAL_CONFIGURATION.AXIS2_PLACEMENT_3D' IN
        TYPEOF (it)))) = 1);
  WR9: (NOT (SELF\representation.name = 'rectangle to ellipse')) OR
    (SIZEOF (QUERY (it <* SELF.items |
      (it.name = 'x size') AND
      (SIZEOF (['PLANT_SPATIAL_CONFIGURATION.MEASURE_REPRESENTATION_ITEM',
        'PLANT_SPATIAL_CONFIGURATION.LENGTH_MEASURE_WITH_UNIT'] *
        TYPEOF (it)) = 2) AND
      ('PLANT_SPATIAL_CONFIGURATION.POSITIVE_LENGTH_MEASURE' IN
        TYPEOF (it\measure_with_unit.value_component)))) = 1);
  WR10: (NOT (SELF\representation.name = 'rectangle to ellipse')) OR

```

```

(SIZEOF (QUERY (it <* SELF.items |
(it.name = 'y size') AND
(SIZEOF ([ 'PLANT_SPATIAL_CONFIGURATION.MEASURE_REPRESENTATION_ITEM',
'PLANT_SPATIAL_CONFIGURATION.LENGTH_MEASURE_WITH_UNIT'] *
TYPEOF (it)) = 2) AND
('PLANT_SPATIAL_CONFIGURATION.POSITIVE_LENGTH_MEASURE' IN
TYPEOF (it\measure_with_unit.value_component)))) = 1);
WR11: (NOT (SELF\representation.name = 'rectangle to ellipse')) OR
(SIZEOF (QUERY (it <* SELF.items |
(it.name = 'height') AND
(SIZEOF ([ 'PLANT_SPATIAL_CONFIGURATION.MEASURE_REPRESENTATION_ITEM',
'PLANT_SPATIAL_CONFIGURATION.LENGTH_MEASURE_WITH_UNIT'] *
TYPEOF (it)) = 2) AND
('PLANT_SPATIAL_CONFIGURATION.POSITIVE_LENGTH_MEASURE' IN
TYPEOF (it\measure_with_unit.value_component)))) = 1);
WR12: (NOT (SELF\representation.name = 'rectangle to ellipse')) OR
(SIZEOF (QUERY (it <* SELF.items |
(it.name = 'x offset') AND
(SIZEOF ([ 'PLANT_SPATIAL_CONFIGURATION.MEASURE_REPRESENTATION_ITEM',
'PLANT_SPATIAL_CONFIGURATION.LENGTH_MEASURE_WITH_UNIT'] *
TYPEOF (it)) = 2))) = 1);
WR13: (NOT (SELF\representation.name = 'rectangle to ellipse')) OR
(SIZEOF (QUERY (it <* SELF.items |
(it.name = 'y offset') AND
(SIZEOF ([ 'PLANT_SPATIAL_CONFIGURATION.MEASURE_REPRESENTATION_ITEM',
'PLANT_SPATIAL_CONFIGURATION.LENGTH_MEASURE_WITH_UNIT'] *
TYPEOF (it)) = 2))) = 1);
WR14: (NOT (SELF\representation.name = 'rectangle to ellipse')) OR
(SIZEOF (QUERY (it <* SELF.items |
(it.name = 'semi axis 1') AND
(SIZEOF ([ 'PLANT_SPATIAL_CONFIGURATION.MEASURE_REPRESENTATION_ITEM',
'PLANT_SPATIAL_CONFIGURATION.LENGTH_MEASURE_WITH_UNIT'] *
TYPEOF (it)) = 2))) = 1);
WR15: (NOT (SELF\representation.name = 'rectangle to ellipse')) OR
(SIZEOF (QUERY (it <* SELF.items |
(it.name = 'semi axis 2') AND
(SIZEOF ([ 'PLANT_SPATIAL_CONFIGURATION.MEASURE_REPRESENTATION_ITEM',
'PLANT_SPATIAL_CONFIGURATION.LENGTH_MEASURE_WITH_UNIT'] *
TYPEOF (it)) = 2))) = 1);
WR16: (NOT (SELF\representation.name = 'trimmed sphere')) OR
(SIZEOF (SELF.items) = 3);
WR17: (NOT (SELF\representation.name = 'trimmed sphere')) OR
(SIZEOF (QUERY (it <* SELF.items |
(it.name = 'base sphere') AND
('PLANT_SPATIAL_CONFIGURATION.SPHERE' IN
TYPEOF (it)))) = 1);
WR18: (NOT (SELF\representation.name = 'trimmed sphere')) OR
(SIZEOF (QUERY (it <* SELF.items |
(it.name = 'cutting plane normal direction') AND
('PLANT_SPATIAL_CONFIGURATION.DIRECTION' IN
TYPEOF (it)))) = 1);
WR19: (NOT (SELF\representation.name = 'trimmed sphere')) OR
(SIZEOF (QUERY (it <* SELF.items |
(it.name = 'height') AND
(SIZEOF ([ 'PLANT_SPATIAL_CONFIGURATION.MEASURE_REPRESENTATION_ITEM',
'PLANT_SPATIAL_CONFIGURATION.LENGTH_MEASURE_WITH_UNIT'] *
TYPEOF (it)) = 2))) = 1);
WR20: (NOT (SELF\representation.name = 'trimmed sphere')) OR
(SIZEOF (QUERY (ht <* QUERY (it <* SELF.items |
(it.name = 'height') AND
(SIZEOF ([ 'PLANT_SPATIAL_CONFIGURATION.MEASURE_REPRESENTATION_ITEM',
'PLANT_SPATIAL_CONFIGURATION.LENGTH_MEASURE_WITH_UNIT'] *
TYPEOF (it)) = 2)) |
NOT (SIZEOF (QUERY (sphre <* QUERY (it <* SELF.items |
(it.name = 'base sphere') AND
('PLANT_SPATIAL_CONFIGURATION.SPHERE' IN TYPEOF (it))) |
NOT ({-sphre.radius < ht.value_component < sphre.radius})))
= 0))) = 0);
WR21: (NOT (SELF\representation.name = 'trimmed pyramid')) OR
(SIZEOF (SELF.items) = 8);

```

```

WR22: (NOT (SELF\representation.name = 'trimmed pyramid')) OR
      (SIZEOF (QUERY (it <* SELF.items |
      (it.name = 'base position') AND
      ('PLANT_SPATIAL_CONFIGURATION.AXIS2_PLACEMENT_3D' IN
      TYPEOF (it)))) = 1));
WR23: (NOT (SELF\representation.name = 'trimmed pyramid')) OR
      (SIZEOF (QUERY (it <* SELF.items |
      (it.name = 'base length') AND
      (SIZEOF (['PLANT_SPATIAL_CONFIGURATION.MEASURE_REPRESENTATION_ITEM',
      'PLANT_SPATIAL_CONFIGURATION.LENGTH_MEASURE_WITH_UNIT'] *
      TYPEOF (it)) = 2))) = 1));
WR24: (NOT (SELF\representation.name = 'trimmed pyramid')) OR
      (SIZEOF (QUERY (it <* SELF.items |
      (it.name = 'base width') AND
      (SIZEOF (['PLANT_SPATIAL_CONFIGURATION.MEASURE_REPRESENTATION_ITEM',
      'PLANT_SPATIAL_CONFIGURATION.LENGTH_MEASURE_WITH_UNIT'] *
      TYPEOF (it)) = 2))) = 1));
WR25: (NOT (SELF\representation.name = 'trimmed pyramid')) OR
      (SIZEOF (QUERY (it <* SELF.items |
      (it.name = 'height') AND
      (SIZEOF (['PLANT_SPATIAL_CONFIGURATION.MEASURE_REPRESENTATION_ITEM',
      'PLANT_SPATIAL_CONFIGURATION.LENGTH_MEASURE_WITH_UNIT'] *
      TYPEOF (it)) = 2))) = 1));
WR26: (NOT (SELF\representation.name = 'trimmed pyramid')) OR
      (SIZEOF (QUERY (it <* SELF.items |
      (it.name = 'top centre x') AND
      (SIZEOF (['PLANT_SPATIAL_CONFIGURATION.MEASURE_REPRESENTATION_ITEM',
      'PLANT_SPATIAL_CONFIGURATION.LENGTH_MEASURE_WITH_UNIT'] *
      TYPEOF (it)) = 2))) = 1));
WR27: (NOT (SELF\representation.name = 'trimmed pyramid')) OR
      (SIZEOF (QUERY (it <* SELF.items |
      (it.name = 'top centre y') AND
      (SIZEOF (['PLANT_SPATIAL_CONFIGURATION.MEASURE_REPRESENTATION_ITEM',
      'PLANT_SPATIAL_CONFIGURATION.LENGTH_MEASURE_WITH_UNIT'] *
      TYPEOF (it)) = 2))) = 1));
WR28: (NOT (SELF\representation.name = 'trimmed pyramid')) OR
      (SIZEOF (QUERY (it <* SELF.items |
      (it.name = 'top length') AND
      (SIZEOF (['PLANT_SPATIAL_CONFIGURATION.MEASURE_REPRESENTATION_ITEM',
      'PLANT_SPATIAL_CONFIGURATION.LENGTH_MEASURE_WITH_UNIT'] *
      TYPEOF (it)) = 2))) = 1));
WR29: (NOT (SELF\representation.name = 'trimmed pyramid')) OR
      (SIZEOF (QUERY (it <* SELF.items |
      (it.name = 'top width') AND
      (SIZEOF (['PLANT_SPATIAL_CONFIGURATION.MEASURE_REPRESENTATION_ITEM',
      'PLANT_SPATIAL_CONFIGURATION.LENGTH_MEASURE_WITH_UNIT'] *
      TYPEOF (it)) = 2))) = 1));
END_ENTITY;
(*

```

#### Formal propositions:

**WR1:** The **plant\_design\_csg\_primitive** shall be defined in three dimensions.

**WR2:** The **plant\_design\_csg\_primitive** shall have a single name. The name attribute shall have the same value for the name attribute of the **representation** and **representation\_item**.

**WR3:** The **plant\_design\_csg\_primitive** shall have a name of either 'hemisphere', 'rectangle to ellipse', 'trimmed sphere', or 'trimmed pyramid'.

**WR4:** If the name of the **plant\_design\_csg\_primitive** is 'hemisphere', it shall be defined by exactly two **representation\_items**.

**WR5:** If the name of the **plant\_design\_csg\_primitive** is 'hemisphere', exactly one of the **representation\_items** in its definition shall be an **axis2\_placement\_3d** with a name of 'position'.

**WR6:** If the name of the **plant\_design\_csg\_primitive** is 'hemisphere', exactly one of the **representation\_items** in its definition shall be a **measure\_representation\_item** and **length\_measure\_-with\_unit** with a name of 'radius'.

**WR7:** If the name of the **plant\_design\_csg\_primitive** is 'rectangle to ellipse', it shall be defined by exactly eight **representation\_items**.

**WR8:** If the name of the **plant\_design\_csg\_primitive** is 'rectangle to ellipse', exactly one of the **representation\_items** in its definition shall be an **axis2\_placement\_3d** with a name of 'position'.

**WR9:** If the name of the **plant\_design\_csg\_primitive** is 'rectangle to ellipse', exactly one of the **representation\_items** in its definition shall be a **measure\_representation\_item** and **length\_measure\_-with\_unit** with a name of 'x size', the value of which is positive.

**WR10:** If the name of the **plant\_design\_csg\_primitive** is 'rectangle to ellipse', exactly one of the **representation\_items** in its definition shall be a **measure\_representation\_item** and **length\_measure\_-with\_unit** with a name of 'y size', the value of which is positive.

**WR11:** If the name of the **plant\_design\_csg\_primitive** is 'rectangle to ellipse', exactly one of the **representation\_items** in its definition shall be a **measure\_representation\_item** and **length\_measure\_-with\_unit** with a name of 'height', the value of which is positive.

**WR12:** If the name of the **plant\_design\_csg\_primitive** is 'rectangle to ellipse', exactly one of the **representation\_items** in its definition shall be a **measure\_representation\_item** and **length\_measure\_-with\_unit** with a name of 'x offset'.

**WR13:** If the name of the **plant\_design\_csg\_primitive** is 'rectangle to ellipse', exactly one of the **representation\_items** in its definition shall be a **measure\_representation\_item** and **length\_measure\_-with\_unit** with a name of 'y offset'.

**WR14:** If the name of the **plant\_design\_csg\_primitive** is 'rectangle to ellipse', exactly one of the **representation\_items** in its definition shall be a **measure\_representation\_item** and **length\_measure\_-with\_unit** with a name of 'semi axis 1'.

**WR15:** If the name of the **plant\_design\_csg\_primitive** is 'rectangle to ellipse', exactly one of the **representation\_items** in its definition shall be a **measure\_representation\_item** and **length\_measure\_-with\_unit** with a name of 'semi axis 2'.

**WR16:** If the name of the **plant\_design\_csg\_primitive** is 'trimmed sphere', it shall be defined by exactly three **representation\_items**.

**WR17:** If the name of the **plant\_design\_csg\_primitive** is 'trimmed sphere', exactly one of the **representation\_items** in its definition shall be a sphere with a name of 'base sphere'.

**WR18:** If the name of the **plant\_design\_csg\_primitive** is 'trimmed sphere', exactly one of the **representation\_items** in its definition shall be a direction with a name of 'cutting plane normal direction'.

**WR19:** If the name of the **plant\_design\_csg\_primitive** is 'trimmed sphere', exactly one of the **representation\_items** in its definition shall be a **measure\_representation\_item** and **length\_measure\_-with\_unit** with a name of 'radius'.

**WR20:** If the name of the **plant\_design\_csg\_primitive** is 'hemisphere', the value of the height

parameter shall vary between negative radius and positive radius of the sphere.

**WR21:** If the name of the **plant\_design\_csg\_primitive** is ‘trimmed pyramid’, it shall be defined by exactly two **representation\_items**.

**WR22:** If the name of the **plant\_design\_csg\_primitive** is ‘trimmed pyramid’, exactly one of the **representation\_items** in its definition shall be an **axis2\_placement\_3d** with a name of ‘base position’.

**WR23:** If the name of the **plant\_design\_csg\_primitive** is ‘trimmed pyramid’, exactly one of the **representation\_items** in its definition shall be a **measure\_representation\_item** and **length\_measure\_-with\_unit** with a name of ‘base length’.

**WR24:** If the name of the **plant\_design\_csg\_primitive** is ‘trimmed pyramid’, exactly one of the **representation\_items** in its definition shall be a **measure\_representation\_item** and **length\_measure\_-with\_unit** with a name of ‘base width’.

**WR25:** If the name of the **plant\_design\_csg\_primitive** is ‘trimmed pyramid’, exactly one of the **representation\_items** in its definition shall be a **measure\_representation\_item** and **length\_measure\_-with\_unit** with a name of ‘height’.

**WR26:** If the name of the **plant\_design\_csg\_primitive** is ‘trimmed pyramid’, exactly one of the **representation\_items** in its definition shall be a **measure\_representation\_item** and **length\_measure\_-with\_unit** with a name of ‘top centre x’.

**WR27:** If the name of the **plant\_design\_csg\_primitive** is ‘trimmed pyramid’, exactly one of the **representation\_items** in its definition shall be a **measure\_representation\_item** and **length\_measure\_-with\_unit** with a name of ‘top centre y’.

**WR28:** If the name of the **plant\_design\_csg\_primitive** is ‘trimmed pyramid’, exactly one of the **representation\_items** in its definition shall be a **measure\_representation\_item** and **length\_measure\_-with\_unit** with a name of ‘top length’.

**WR29:** If the name of the **plant\_design\_csg\_primitive** is ‘trimmed pyramid’, exactly one of the **representation\_items** in its definition shall be a **measure\_representation\_item** and **length\_measure\_-with\_unit** with a name of ‘top width’.

Associated global rule:

The following global rule defined in this part of ISO 10303 applies to the **plant\_design\_csg\_primitive** entity:

- **subtype\_mandatory\_shape\_representation** (see 5.2.4.18)

### 5.2.3.1.77 **plant\_item\_connection**

A **plant\_item\_connection** is a type of **shape\_aspect** and **shape\_aspect\_relationship** that identifies a connection between plant items.

**NOTE** A connection is a **shape\_aspect** of the physical assembly where the two plant items are connected.

EXPRESS specification:

```
* )
ENTITY plant_item_connection
    SUBTYPE OF (shape_aspect, shape_aspect_relationship);
```

```

WHERE
  WR1: 'PLANT_SPATIAL_CONFIGURATION.PLANT_ITEM_CONNECTOR' IN
    TYPEOF (SELF\shape_aspect_relationship.relatng_shape_aspect);
  WR2: 'PLANT_SPATIAL_CONFIGURATION.PLANT_ITEM_CONNECTOR' IN
    TYPEOF (SELF\shape_aspect_relationship.related_shape_aspect);
  WR3: SELF\shape_aspect.of_shape\property_definition.
    definition\product_definition.
    frame_of_reference\application_context_element.name IN
    ['functional occurrence', 'physical occurrence',
    'functional definition', 'physical definition'];
  WR4: (SELF\shape_aspect_relationship.relatng_shape_aspect.
    of_shape\property_definition.definition\product_definition.
    frame_of_reference\application_context_element.name =
    SELF\shape_aspect_relationship.related_shape_aspect.
    of_shape\property_definition.definition\product_definition.
    frame_of_reference\application_context_element.name);
  WR5: SIZEOF (USEDIN (SELF, 'PLANT_SPATIAL_CONFIGURATION.' +
    'APPLIED_CLASSIFICATION_ASSIGNMENT.ITEMS')) >= 1;
  WR6: SIZEOF (QUERY (pscca <* USEDIN (SELF,
    'PLANT_SPATIAL_CONFIGURATION.' +
    'APPLIED_CLASSIFICATION_ASSIGNMENT.ITEMS') |
    NOT (SIZEOF (
    ['PLANT_SPATIAL_CONFIGURATION.CONNECTION_FUNCTIONAL_CLASS',
    'PLANT_SPATIAL_CONFIGURATION.CONNECTION_MOTION_CLASS'] *
    TYPEOF (pscca.assigned_class)) >= 1))) = 0;
  WR7: SIZEOF (QUERY (pdr <* USEDIN (SELF.of_shape.definition,
    'PLANT_SPATIAL_CONFIGURATION.PRODUCT_DEFINITION_RELATIONSHIP.' +
    'RELATED_PRODUCT_DEFINITION') |
    pdr.name = 'support usage connection')) <= 1;
END_ENTITY;
( *

```

#### Formal propositions:

**WR1:** The **relating\_shape\_aspect** of a **plant\_item\_connection** shall be a **plant\_item\_connector**.

**WR2:** The **related\_shape\_aspect** of a **plant\_item\_connection** shall be a **plant\_item\_connector**.

**WR3:** The **application\_context\_element** that applies to a **plant\_item\_connection** shall have the name 'functional occurrence', 'physical occurrence', 'functional definition', or 'physical definition'.

**WR4:** The **application\_context\_elements** that apply to the **relating\_shape\_aspect** and the **related\_shape\_aspect** of a **plant\_item\_connection** shall have the same name.

**WR5:** A **plant\_item\_connection** shall be classified at least once.

**WR6:** A **plant\_item\_connection** shall be classified as a **connection\_functional\_class**, as a **connection\_motion\_class**, or as both.

**WR7:** The **product\_definition** of the **plant\_item\_connection** shall be the **related\_product\_definition** in at most one **product\_definition\_relationship** with a name of 'support usage connection'.

#### Associated global rules:

The following global rules defined in this part of ISO 10303 apply to the **plant\_item\_connection** entity:

- **application\_context\_requires\_ap\_definition** (see 5.2.4.1);
- **dependent\_instantiable\_application\_context** (see 5.2.4.9);
- **dependent\_instantiable\_product\_definition\_context** (see 5.2.4.11);

- **product\_definition\_context\_name\_constraint** (see 5.2.4.13);
- **product\_definition\_usage\_constraint** (see 5.2.4.14).

### 5.2.3.1.78 plant\_item\_connector

A **plant\_item\_connector** is a type of **shape\_aspect** that identifies a feature of a plant item that is designed to connect to another connector.

#### EXPRESS specification:

```

*)
ENTITY plant_item_connector
  SUBTYPE OF(shape_aspect);
WHERE
  WR1: SELF\shape_aspect.of_shape\property_definition.
        definition\product_definition.
        frame_of_reference\application_context_element.name IN
        ['functional definition', 'physical definition',
        'functional occurrence', 'physical occurrence'];
  WR2: SIZEOF (QUERY (pic <*
        (bag_to_set (USEDIN (SELF, 'PLANT_SPATIAL_CONFIGURATION.' +
        'SHAPE_ASPECT_RELATIONSHIP.RELATED_SHAPE_ASPECT')) +
        bag_to_set (USEDIN (SELF, 'PLANT_SPATIAL_CONFIGURATION.' +
        'SHAPE_ASPECT_RELATIONSHIP.RELATING_SHAPE_ASPECT')) |
        'PLANT_SPATIAL_CONFIGURATION.PLANT_ITEM_CONNECTION' IN
        TYPEOF (pic))) <= 1;
  WR3: (NOT (SIZEOF (QUERY (aca <* USEDIN (SELF,
        'PLANT_SPATIAL_CONFIGURATION.' +
        'APPLIED_CLASSIFICATION_ASSIGNMENT.ITEMS') |
        SIZEOF (TYPEOF (aca.assigned_class) *
        ['PLANT_SPATIAL_CONFIGURATION.PIPING_CONNECTOR_CLASS',
        'PLANT_SPATIAL_CONFIGURATION.CONNECTOR_END_TYPE_CLASS'])
        = 1)) >= 1)) OR
        ((NOT (SIZEOF (QUERY (pd <* USEDIN (SELF,
        'PLANT_SPATIAL_CONFIGURATION.PROPERTY_DEFINITION.DEFINITION') |
        pd.name = 'service characteristics')) >= 1)) OR
        (SIZEOF (QUERY (sc <* QUERY (pd <* USEDIN (SELF,
        'PLANT_SPATIAL_CONFIGURATION.PROPERTY_DEFINITION.DEFINITION') |
        pd.name = 'service characteristics') |
        NOT (SIZEOF (QUERY (pdr <* USEDIN (sc,
        'PLANT_SPATIAL_CONFIGURATION.' +
        'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') |
        pdr.used_representation.name =
        'design service characteristics')) = 1))) = 0))) = 0));
  WR4: (NOT (SIZEOF (QUERY (aca <* USEDIN (SELF,
        'PLANT_SPATIAL_CONFIGURATION.' +
        'APPLIED_CLASSIFICATION_ASSIGNMENT.ITEMS') |
        SIZEOF (TYPEOF (aca.assigned_class) *
        ['PLANT_SPATIAL_CONFIGURATION.PIPING_CONNECTOR_CLASS',
        'PLANT_SPATIAL_CONFIGURATION.CONNECTOR_END_TYPE_CLASS'])
        = 1)) >= 1)) OR
        (NOT (SIZEOF (QUERY (pd <* USEDIN (SELF,
        'PLANT_SPATIAL_CONFIGURATION.PROPERTY_DEFINITION.DEFINITION') |
        (pd.name = 'service characteristics') )) >= 1)) OR
        (SIZEOF (QUERY (sc <* QUERY (pd <* USEDIN (SELF,
        'PLANT_SPATIAL_CONFIGURATION.PROPERTY_DEFINITION.DEFINITION') |
        pd.name = 'service characteristics') |
        NOT (SIZEOF (QUERY (dsc <* QUERY (pdr <* USEDIN (sc,
        'PLANT_SPATIAL_CONFIGURATION.' +
        'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') |
        pdr.used_representation.name = 'design service characteristics') |
        SIZEOF (dsc.used_representation.items) >= 2)) = 1))) = 0));
  WR5: (NOT (SIZEOF (QUERY (aca <* USEDIN (SELF,
        'PLANT_SPATIAL_CONFIGURATION.' +
        'APPLIED_CLASSIFICATION_ASSIGNMENT.ITEMS') |
        SIZEOF (TYPEOF (aca.assigned_class) *

```

```

[ 'PLANT_SPATIAL_CONFIGURATION.PIPING_CONNECTOR_CLASS',
  'PLANT_SPATIAL_CONFIGURATION.CONNECTOR_END_TYPE_CLASS']]
= 1)) >= 1)) OR
((NOT (SIZEOF (QUERY (pd <* USEDIN (SELF,
  'PLANT_SPATIAL_CONFIGURATION.PROPERTY_DEFINITION.DEFINITION')) |
pd.name = 'service characteristics')) >= 1)) OR
(SIZEOF (QUERY (sc <* QUERY (pd <* USEDIN (SELF,
  'PLANT_SPATIAL_CONFIGURATION.PROPERTY_DEFINITION.DEFINITION')) |
pd.name = 'service characteristics')) |
NOT (SIZEOF (QUERY (dsc <* QUERY (pdr <* USEDIN (sc,
  'PLANT_SPATIAL_CONFIGURATION.' +
  'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION')) |
pdr.used_representation.name = 'design service characteristics')) |
{1 <= SIZEOF (QUERY (it <* dsc.used_representation.items |
  ('PLANT_SPATIAL_CONFIGURATION.MEASURE_REPRESENTATION_ITEM' IN
  TYPEOF (it)) AND
  (it.name IN ['pressure', 'minimum pressure',
    'maximum pressure'])) <= 2})) = 1))) = 0));
WR6: (NOT (SIZEOF (QUERY (aca <* USEDIN (SELF,
  'PLANT_SPATIAL_CONFIGURATION.' +
  'APPLIED_CLASSIFICATION_ASSIGNMENT.ITEMS')) |
SIZEOF (TYPEOF (aca.assigned_class) *
  ['PLANT_SPATIAL_CONFIGURATION.PIPING_CONNECTOR_CLASS',
  'PLANT_SPATIAL_CONFIGURATION.CONNECTOR_END_TYPE_CLASS']))
= 1)) >= 1)) OR
((NOT (SIZEOF (QUERY (pd <* USEDIN (SELF,
  'PLANT_SPATIAL_CONFIGURATION.PROPERTY_DEFINITION.DEFINITION')) |
pd.name = 'service characteristics')) >= 1)) OR
(SIZEOF (QUERY (sc <* QUERY (pd <* USEDIN (SELF,
  'PLANT_SPATIAL_CONFIGURATION.PROPERTY_DEFINITION.DEFINITION')) |
pd.name = 'service characteristics')) |
NOT (SIZEOF (QUERY (dsc <* QUERY (pdr <* USEDIN (sc,
  'PLANT_SPATIAL_CONFIGURATION.' +
  'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION')) |
pdr.used_representation.name = 'design service characteristics')) |
SIZEOF (QUERY (it <* dsc.used_representation.items |
  ('PLANT_SPATIAL_CONFIGURATION.MEASURE_REPRESENTATION_ITEM' IN
  TYPEOF (it)) AND
  (it.name = 'pressure')) <= 1)) = 1))) = 0));
WR7: (NOT (SIZEOF (QUERY (aca <* USEDIN (SELF,
  'PLANT_SPATIAL_CONFIGURATION.' +
  'APPLIED_CLASSIFICATION_ASSIGNMENT.ITEMS')) |
SIZEOF (TYPEOF (aca.assigned_class) *
  ['PLANT_SPATIAL_CONFIGURATION.PIPING_CONNECTOR_CLASS',
  'PLANT_SPATIAL_CONFIGURATION.CONNECTOR_END_TYPE_CLASS']))
= 1)) >= 1)) OR
((NOT (SIZEOF (QUERY (pd <* USEDIN (SELF,
  'PLANT_SPATIAL_CONFIGURATION.PROPERTY_DEFINITION.DEFINITION')) |
pd.name = 'service characteristics')) >= 1)) OR
(SIZEOF (QUERY (sc <* QUERY (pd <* USEDIN (SELF,
  'PLANT_SPATIAL_CONFIGURATION.PROPERTY_DEFINITION.DEFINITION')) |
pd.name = 'service characteristics')) |
NOT (SIZEOF (QUERY (dsc <* QUERY (pdr <* USEDIN (sc,
  'PLANT_SPATIAL_CONFIGURATION.' +
  'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION')) |
pdr.used_representation.name = 'design service characteristics')) |
SIZEOF (QUERY (it <* dsc.used_representation.items |
  ('PLANT_SPATIAL_CONFIGURATION.MEASURE_REPRESENTATION_ITEM' IN
  TYPEOF (it)) AND
  (it.name = 'minimum pressure')) <= 1)) = 1))) = 0));
WR8: (NOT (SIZEOF (QUERY (aca <* USEDIN (SELF,
  'PLANT_SPATIAL_CONFIGURATION.' +
  'APPLIED_CLASSIFICATION_ASSIGNMENT.ITEMS')) |
SIZEOF (TYPEOF (aca.assigned_class) *
  ['PLANT_SPATIAL_CONFIGURATION.PIPING_CONNECTOR_CLASS',
  'PLANT_SPATIAL_CONFIGURATION.CONNECTOR_END_TYPE_CLASS']))
= 1)) >= 1)) OR
((NOT (SIZEOF (QUERY (pd <* USEDIN (SELF,
  'PLANT_SPATIAL_CONFIGURATION.PROPERTY_DEFINITION.DEFINITION')) |
pd.name = 'service characteristics')) >= 1)) OR

```

```

        (sizeof (QUERY (sc <* QUERY (pd <* USEDIN (SELF,
        'PLANT_SPATIAL_CONFIGURATION.PROPERTY_DEFINITION.DEFINITION') |
        pd.name = 'service characteristics') |
        NOT (sizeof (QUERY (dsc <* QUERY (pdr <* USEDIN (sc,
        'PLANT_SPATIAL_CONFIGURATION.' +
        'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') |
        pdr.used_representation.name = 'design service characteristics') |
        sizeof (QUERY (it <* dsc.used_representation.items |
        ('PLANT_SPATIAL_CONFIGURATION.MEASURE_REPRESENTATION_ITEM' IN
        TYPEOF (it)) AND
        (it.name = 'maximum pressure')) <= 1)) = 1))) = 0));
WR9: (NOT (sizeof (QUERY (aca <* USEDIN (SELF,
        'PLANT_SPATIAL_CONFIGURATION.' +
        'APPLIED_CLASSIFICATION_ASSIGNMENT.ITEMS') |
        sizeof (typeof (aca.assigned_class) *
        ['PLANT_SPATIAL_CONFIGURATION.PIPING_CONNECTOR_CLASS',
        'PLANT_SPATIAL_CONFIGURATION.CONNECTOR_END_TYPE_CLASS'])
        = 1)) >= 1)) OR
        ((NOT (sizeof (QUERY (pd <* USEDIN (SELF,
        'PLANT_SPATIAL_CONFIGURATION.PROPERTY_DEFINITION.DEFINITION') |
        pd.name = 'service characteristics')) >= 1)) OR
        (sizeof (QUERY (sc <* QUERY (pd <* USEDIN (SELF,
        'PLANT_SPATIAL_CONFIGURATION.PROPERTY_DEFINITION.DEFINITION') |
        pd.name = 'service characteristics') |
        NOT (sizeof (QUERY (dsc <* QUERY (pdr <* USEDIN (sc,
        'PLANT_SPATIAL_CONFIGURATION.' +
        'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') |
        pdr.used_representation.name = 'design service characteristics') |
        {1 <= sizeof (QUERY (it <* dsc.used_representation.items |
        (sizeof (typeof (it) *
        ['PLANT_SPATIAL_CONFIGURATION.MEASURE_REPRESENTATION_ITEM',
        'PLANT_SPATIAL_CONFIGURATION.' +
        'THERMODYNAMIC_TEMPERATURE_MEASURE_WITH_UNIT']) = 2) AND
        (it.name IN ['temperature', 'minimum temperature',
        'maximum temperature']))) <= 2}))) = 1))) = 0));
WR10: (NOT (sizeof (QUERY (aca <* USEDIN (SELF,
        'PLANT_SPATIAL_CONFIGURATION.' +
        'APPLIED_CLASSIFICATION_ASSIGNMENT.ITEMS') |
        sizeof (typeof (aca.assigned_class) *
        ['PLANT_SPATIAL_CONFIGURATION.PIPING_CONNECTOR_CLASS',
        'PLANT_SPATIAL_CONFIGURATION.CONNECTOR_END_TYPE_CLASS'])
        = 1)) >= 1)) OR
        ((NOT (sizeof (QUERY (pd <* USEDIN (SELF,
        'PLANT_SPATIAL_CONFIGURATION.PROPERTY_DEFINITION.DEFINITION') |
        pd.name = 'service characteristics')) >= 1)) OR
        (sizeof (QUERY (sc <* QUERY (pd <* USEDIN (SELF,
        'PLANT_SPATIAL_CONFIGURATION.PROPERTY_DEFINITION.DEFINITION') |
        pd.name = 'service characteristics') |
        NOT (sizeof (QUERY (dsc <* QUERY (pdr <* USEDIN (sc,
        'PLANT_SPATIAL_CONFIGURATION.' +
        'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') |
        pdr.used_representation.name = 'design service characteristics') |
        sizeof (QUERY (it <* dsc.used_representation.items |
        (sizeof (typeof (it) *
        ['PLANT_SPATIAL_CONFIGURATION.MEASURE_REPRESENTATION_ITEM',
        'PLANT_SPATIAL_CONFIGURATION.' +
        'THERMODYNAMIC_TEMPERATURE_MEASURE_WITH_UNIT']) = 2) AND
        (it.name = 'temperature')) <= 1)) = 1))) = 0));
WR11: (NOT (sizeof (QUERY (aca <* USEDIN (SELF,
        'PLANT_SPATIAL_CONFIGURATION.' +
        'APPLIED_CLASSIFICATION_ASSIGNMENT.ITEMS') |
        sizeof (typeof (aca.assigned_class) *
        ['PLANT_SPATIAL_CONFIGURATION.PIPING_CONNECTOR_CLASS',
        'PLANT_SPATIAL_CONFIGURATION.CONNECTOR_END_TYPE_CLASS'])
        = 1)) >= 1)) OR
        ((NOT (sizeof (QUERY (pd <* USEDIN (SELF,
        'PLANT_SPATIAL_CONFIGURATION.PROPERTY_DEFINITION.DEFINITION') |
        pd.name = 'service characteristics')) >= 1)) OR
        (sizeof (QUERY (sc <* QUERY (pd <* USEDIN (SELF,
        'PLANT_SPATIAL_CONFIGURATION.PROPERTY_DEFINITION.DEFINITION') |

```

```

pd.name = 'service characteristics') |
NOT (SIZEOF (QUERY (dsc <* QUERY (pdr <* USEDIN (sc,
'PLANT_SPATIAL_CONFIGURATION.' +
'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') |
pdr.used_representation.name = 'design service characteristics') |
SIZEOF (QUERY (it <* dsc.used_representation.items |
(SIZEOF (TYPEOF (it) *
['PLANT_SPATIAL_CONFIGURATION.MEASURE_REPRESENTATION_ITEM',
'PLANT_SPATIAL_CONFIGURATION.' +
'THERMODYNAMIC_TEMPERATURE_MEASURE_WITH_UNIT']) = 2) AND
(it.name = 'minimum temperature')))) <= 1)) = 1))) = 0));
WR12: (NOT (SIZEOF (QUERY (aca <* USEDIN (SELF,
'PLANT_SPATIAL_CONFIGURATION.' +
'APPLIED_CLASSIFICATION_ASSIGNMENT.ITEMS') |
SIZEOF (TYPEOF (aca.assigned_class) *
['PLANT_SPATIAL_CONFIGURATION.PIPING_CONNECTOR_CLASS',
'PLANT_SPATIAL_CONFIGURATION.CONNECTOR_END_TYPE_CLASS'])
= 1)) >= 1)) OR
((NOT (SIZEOF (QUERY (pd <* USEDIN (SELF,
'PLANT_SPATIAL_CONFIGURATION.PROPERTY_DEFINITION.DEFINITION') |
pd.name = 'service characteristics')) >= 1)) OR
(SIZEOF (QUERY (sc <* QUERY (pd <* USEDIN (SELF,
'PLANT_SPATIAL_CONFIGURATION.PROPERTY_DEFINITION.DEFINITION') |
pd.name = 'service characteristics') |
NOT (SIZEOF (QUERY (dsc <* QUERY (pdr <* USEDIN (sc,
'PLANT_SPATIAL_CONFIGURATION.' +
'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') |
pdr.used_representation.name = 'design service characteristics') |
SIZEOF (QUERY (it <* dsc.used_representation.items |
(SIZEOF (TYPEOF (it) *
['PLANT_SPATIAL_CONFIGURATION.MEASURE_REPRESENTATION_ITEM',
'PLANT_SPATIAL_CONFIGURATION.' +
'THERMODYNAMIC_TEMPERATURE_MEASURE_WITH_UNIT']) = 2) AND
(it.name = 'maximum temperature')))) <= 1)) = 1))) = 0));
WR13: (NOT (SELF\shape_aspect.of_shape\property_definition.
definition\product_definition.
frame_of_reference\application_context_element.name IN
['functional definition', 'functional occurrence'])) OR
(SIZEOF (QUERY (pdr <* USEDIN (SELF, 'PLANT_SPATIAL_CONFIGURATION.' +
'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') |
'PLANT_SPATIAL_CONFIGURATION.SHAPE_REPRESENTATION' IN
TYPEOF (pdr.used_representation))) = 0);
END_ENTITY;
(*

```

#### Formal propositions:

**WR1:** The **application\_context\_element** that applies to a **plant\_item\_connector** (as its **product\_definition\_context**) shall have the name 'functional definition', 'physical definition' 'functional occurrence', or 'physical occurrence'.

**WR2:** The **plant\_item\_connector** shall be the connector in at most one **plant\_item\_connection**.

**WR3:** If the **plant\_item\_connector** is classified as either a piping connector or a connector end type and has a **property\_definition** with a name of 'service characteristics', the **property\_definition** shall have exactly one **representation** with the name of 'design service characteristics'.

**WR4:** If the **plant\_item\_connector** is classified as either a piping connector or a connector end type and has a **property\_definition** with a name of 'service characteristics', the **property\_definition** shall have exactly one **representation** with a name of 'design service characteristics' that has at least two **representation\_items**.

**WR5:** If the **plant\_item\_connector** is classified as either a piping connector or a connector end type and has a **property\_definition** with a name of 'service characteristics', the **property\_definition** shall have

exactly one **representation** with a name of 'design service characteristics' that has one or two **representation\_items** of type **measure\_representation\_item** with a name of 'pressure', 'minimum pressure', or 'maximum pressure'.

**WR6:** If the **plant\_item\_connector** is classified as either a piping connector or a connector end type and has a **property\_definition** with a name of 'service characteristics', the **property\_definition** shall have exactly one **representation** with a name of 'design service characteristics' that has at most one **representation\_item** of type **measure\_representation\_item** with a name of 'pressure'.

**WR7:** If the **plant\_item\_connector** is classified as either a piping connector or a connector end type and has a **property\_definition** with a name of 'service characteristics', the **property\_definition** shall have exactly one **representation** with a name of 'design service characteristics' that has at most one **representation\_item** of type **measure\_representation\_item** with a name of 'minimum pressure'.

**WR8:** If the **plant\_item\_connector** is classified as either a piping connector or a connector end type and has a **property\_definition** with a name of 'service characteristics', the **property\_definition** shall have exactly one **representation** with a name of 'design service characteristics' that has at most one **representation\_item** of type **measure\_representation\_item** with a name of 'maximum pressure'.

**WR9:** If the **plant\_item\_connector** is classified as either a piping connector or a connector end type and has a **property\_definition** with a name of 'service characteristics', the **property\_definition** shall have exactly one **representation** with a name of 'design service characteristics' that has one or two **representation\_items** of type **measure\_representation\_item** and **thermodynamic\_temperature\_-measure\_with\_unit** with a name of 'temperature', 'minimum temperature', or 'maximum temperature'.

**WR10:** If the **plant\_item\_connector** is classified as either a piping connector or a connector end type and has a **property\_definition** with a **name** of 'service characteristics', the **property\_definition** shall have exactly one **representation** with a **name** of 'design service characteristics' that has at most one **representation\_item** of type **measure\_representation\_item** and **thermodynamic\_temperature\_-measure\_with\_unit** with a **name** of 'temperature'.

**WR11:** If the **plant\_item\_connector** is classified as either a piping connector or a connector end type and has a **property\_definition** with a **name** of 'service characteristics', the **property\_definition** shall have exactly one **representation** with a **name** of 'design service characteristics' that has at most one **representation\_item** of type **measure\_representation\_item** and **thermodynamic\_temperature\_-measure\_with\_unit** with a **name** of 'minimum temperature'.

**WR12:** If the **plant\_item\_connector** is classified as either a piping connector or a connector end type and has a **property\_definition** with a **name** of 'service characteristics', the **property\_definition** shall have exactly one **representation** with a **name** of 'design service characteristics' that has at most one **representation\_item** of type **measure\_representation\_item** and **thermodynamic\_temperature\_-measure\_with\_unit** with a **name** of 'maximum temperature'.

**WR13:** If a **plant\_item\_connector** is a functional connector it shall not have any **shape\_representation**.

#### Associated global rules:

The following global rules defined in this part of ISO 10303 apply to the **plant\_item\_connector** entity:

- **application\_context\_requires\_ap\_definition** (see 5.2.4.1);
- **dependent\_instantiable\_application\_context** (see 5.2.4.9);

- **dependent\_instantiable\_product\_definition\_context** (see 5.2.4.11);
- **product\_definition\_context\_name\_constraint** (see 5.2.4.13);
- **product\_definition\_usage\_constraint** (see 5.2.4.14).

### 5.2.3.1.79 **plant\_item\_interference**

A **plant\_item\_interference** is a type of **product\_definition\_relationship** that identifies interference between plant items.

EXPRESS specification:

```
* )
ENTITY plant_item_interference
  SUBTYPE OF (product_definition_relationship);
END_ENTITY;
( *
```

### 5.2.3.1.80 **plant\_item\_route**

A **plant\_item\_route** is a type of **product\_definition\_shape** that identifies the 3D path of a **plant\_line\_definition** or a **plant\_line\_segment\_definition**.

EXPRESS specification:

```
* )
ENTITY plant_item_route
  SUBTYPE OF (product_definition_shape);
WHERE
  WR1: SELF\property_definition.definition\product_definition.
    frame_of_reference\application_context_element.name =
    'physical occurrence';
  WR2: SIZEOF (TYPEOF (SELF\property_definition.definition) *
    ['PLANT_SPATIAL_CONFIGURATION.PLANT_LINE_DEFINITION',
    'PLANT_SPATIAL_CONFIGURATION.PLANT_LINE_SEGMENT_DEFINITION']) = 1;
END_ENTITY;
( *
```

Formal propositions:

**WR1:** The **name** of the **product\_definition\_context** that a **plant\_item\_route** is related to shall be 'physical occurrence'.

**WR2:** A **plant\_item\_route** shall be the definition of the shape of a **plant\_line\_definition** or a **plant\_line\_segment\_definition**.

Associated global rules:

The following global rules defined in this part of ISO 10303 apply to the **plant\_item\_route** entity:

- **application\_context\_requires\_ap\_definition** (see 5.2.4.1);
- **dependent\_instantiable\_application\_context** (see 5.2.4.9);
- **dependent\_instantiable\_product\_definition\_context** (see 5.2.4.11);

- **product\_definition\_context\_name\_constraint** (see 5.2.4.13);
- **product\_definition\_usage\_constraint** (see 5.2.4.14).

### 5.2.3.1.81 plant\_item\_weight\_representation

A **plant\_item\_weight\_representation** is a type of **property\_definition\_representation** that specifies the weight of plant items.

EXPRESS specification:

```

*)
ENTITY plant_item_weight_representation
  SUBTYPE OF (property_definition_representation);
WHERE
  WR1: SELF.used_representation.name = 'item weight';
  WR2: SIZEOF (SELF.used_representation.items) >= 2;
  WR3: SIZEOF (QUERY (it <* SELF.used_representation.items |
    (it.name IN ['weight value',
    'maximum weight value', 'minimum weight value']) AND
    (NOT (SIZEOF (TYPEOF (it) *
    ['PLANT_SPATIAL_CONFIGURATION.MEASURE_REPRESENTATION_ITEM',
    'PLANT_SPATIAL_CONFIGURATION.QUALIFIED_REPRESENTATION_ITEM']) =
    2)))) = 0;
  WR4: SIZEOF (QUERY (it <* SELF.used_representation.items |
    ('PLANT_SPATIAL_CONFIGURATION.GEOMETRIC_REPRESENTATION_ITEM'
    IN TYPEOF (it)) AND
    (it.name = 'centre of gravity')))) = 1;
  WR5: {1 <= SIZEOF (QUERY (it <* SELF.used_representation.items |
    it.name IN ['weight value',
    'maximum weight value', 'minimum weight value'])) <= 2};
  WR6: SIZEOF (QUERY (it <* SELF\property_definition_representation.
    used_representation.items |
    (it.name IN ['maximum weight value', 'minimum weight value']) AND
    (NOT (SIZEOF (QUERY (tq <* QUERY (qual <*
    it\qualified_representation_item.qualifiers |
    'PLANT_SPATIAL_CONFIGURATION.TYPE_QUALIFIER' IN TYPEOF (qual)) |
    tq.name = 'operating')) = 1)))) = 0;
END_ENTITY;
( *
```

Formal propositions:

**WR1:** The name of the **plant\_item\_weight\_representation** shall be 'item weight'.

**WR2:** The **plant\_item\_weight\_representation** shall contain at least two items.

**WR3:** If the **plant\_item\_weight\_representation** contains a **representation\_item** with a name of 'weight value', 'maximum weight value', or 'minimum weight value', the **representation\_item** shall be a **measure\_representation\_item** and a **qualified\_representation\_item**.

**WR4:** The **plant\_item\_weight\_representation** shall contain exactly one **representation\_item** that is a **geometric\_representation\_item** with a name of 'centre of gravity'.

**WR5:** The **plant\_item\_weight\_representation** shall have between 1 and 2 **representation\_items** with a name of 'weight value', 'maximum weight value', or 'minimum weight value'.

**WR6:** If the **plant\_item\_weight\_representation** has a **representation\_item** with a name of 'maximum weight value' or 'minimum weight value', the **representation\_item** shall have a **type\_qualifier** with a

name of 'operating'.

### 5.2.3.1.82 plant\_line\_definition

A **plant\_line\_definition** is a type of **product\_definition\_with\_associated\_documents** that identifies a piping system line.

EXPRESS specification:

```

*)
ENTITY plant_line_definition
  SUBTYPE OF (product_definition_with_associated_documents);
WHERE
  WR1: SIZEOF (QUERY (pdr <* USEDIN (SELF, 'PLANT_SPATIAL_CONFIGURATION.' +
    'PRODUCT_DEFINITION_RELATIONSHIP.RELATED_PRODUCT_DEFINITION') |
    ('PLANT_SPATIAL_CONFIGURATION.PIPING_SYSTEM' IN
    TYPEOF (pdr.relatng_product_definition))) = 1;
  WR2: SIZEOF (QUERY (pdr <* USEDIN (SELF, 'PLANT_SPATIAL_CONFIGURATION.' +
    'PRODUCT_DEFINITION_RELATIONSHIP.RELATING_PRODUCT_DEFINITION') |
    'PLANT_SPATIAL_CONFIGURATION.PLANT_LINE_SEGMENT_DEFINITION' IN
    TYPEOF (pdr.related_product_definition))) >= 1;
  WR3: (NOT (SIZEOF (QUERY (pd <* USEDIN (SELF,
    'PLANT_SPATIAL_CONFIGURATION.PROPERTY_DEFINITION.DEFINITION') |
    SIZEOF (USEDIN (pd, 'PLANT_SPATIAL_CONFIGURATION.' +
    'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') >= 1)) = 0)) OR
    (SIZEOF (QUERY (pd <* USEDIN (SELF,
    'PLANT_SPATIAL_CONFIGURATION.PROPERTY_DEFINITION.DEFINITION') |
    NOT (SIZEOF (QUERY (pdr <* USEDIN (pd,
    'PLANT_SPATIAL_CONFIGURATION.' +
    'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') |
    SIZEOF (QUERY (rep <*
    USEDIN (pdr.used_representation.context_of_items,
    'PLANT_SPATIAL_CONFIGURATION.REPRESENTATION.CONTEXT_OF_ITEMS') |
    SIZEOF (QUERY (prop_def_rep <* USEDIN (rep,
    'PLANT_SPATIAL_CONFIGURATION.' +
    'PROPERTY_DEFINITION_REPRESENTATION.USED_REPRESENTATION') |
    (SIZEOF ([ 'PLANT_SPATIAL_CONFIGURATION.SITE',
    'PLANT_SPATIAL_CONFIGURATION.SITE_BUILDING'] *
    TYPEOF (prop_def_rep.definition)) = 1) OR
    ('PLANT_SPATIAL_CONFIGURATION.PLANT' IN
    TYPEOF (prop_def_rep.definition.formation.of_product))))
    >= 1)) >= 1)) >= 1))) = 0);
  WR4: SELF.frame_of_reference.name =
    'functional definition';
  WR5: SIZEOF (QUERY (pds <* QUERY (pd <* USEDIN (SELF,
    'PLANT_SPATIAL_CONFIGURATION.PROPERTY_DEFINITION.DEFINITION') |
    'PLANT_SPATIAL_CONFIGURATION.PRODUCT_DEFINITION_SHAPE' IN
    TYPEOF (pd)) |
    NOT (SIZEOF (QUERY (sa <*USEDIN (pds,
    'PLANT_SPATIAL_CONFIGURATION.SHAPE_ASPECT.OF_SHAPE') |
    ('PLANT_SPATIAL_CONFIGURATION.PLANT_LINE_SEGMENT_TERMINATION' IN
    TYPEOF (sa)) AND
    (sa.description = 'piping line termination')) <= 2))) = 0;
END_ENTITY;
( *
```

Formal propositions:

**WR1:** A **plant\_line\_definition** shall be related to exactly one **piping\_system**.

**WR2:** A **plant\_line\_definition** shall be related to at least one **plant\_line\_segment\_definition**.

**WR3:** If a **plant\_line\_definition** has a representation, that representation shall be in the context of a **site\_building**, a **site**, or a **plant**.

**WR4:** A **plant\_line\_definition** shall have an **application\_context\_element.name** of 'functional definition'.

Associated global rules:

The following global rules defined in this part of ISO 10303 apply to the **plant\_line\_definition** entity:

- **application\_context\_requires\_ap\_definition** (see 5.2.4.1);
- **dependent\_instantiable\_application\_context** (see 5.2.4.9);
- **dependent\_instantiable\_product\_definition\_context** (see 5.2.4.11);
- **product\_definition\_context\_name\_constraint** (see 5.2.4.13).

### 5.2.3.1.83 plant\_line\_segment\_definition

A **plant\_line\_segment\_definition** is a type of **product\_definition** that identifies a line segment.

EXPRESS specification:

```

*)
ENTITY plant_line_segment_definition
  SUBTYPE OF (product_definition);
WHERE
  WR1: SIZEOF (QUERY (pdr <* USEDIN (SELF,
    'PLANT_SPATIAL_CONFIGURATIONS.' +
    'PRODUCT_DEFINITION_RELATIONSHIP.RELATED_PRODUCT_DEFINITION') |
    'PLANT_SPATIAL_CONFIGURATIONS.PLANT_LINE_DEFINITION'
  IN TYPEOF (pdr.relate_product_definition))) >= 1;
  WR2: SIZEOF (QUERY (pd <* USEDIN (SELF,
    'PLANT_SPATIAL_CONFIGURATIONS.PROPERTY_DEFINITION.DEFINITION') |
    'PLANT_SPATIAL_CONFIGURATIONS.SHAPE_DEFINITION' IN
  TYPEOF (pd))) >= 1;
  WR3: SELF.frame_of_reference\application_context_element.name =
    'functional definition';
  WR4: SIZEOF (QUERY (pdr <* USEDIN (SELF, 'PLANT_SPATIAL_CONFIGURATIONS.' +
    'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') |
    pdr.used_representation.name = 'line segment characteristics')) = 1;
  WR5: SIZEOF (QUERY (lsc <* QUERY (pdr <* USEDIN (SELF,
    'PLANT_SPATIAL_CONFIGURATIONS.' +
    'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') |
    pdr.used_representation.name = 'line segment characteristics') |
    NOT (SIZEOF (lsc.used_representation.items) >= 2))) = 0;
  WR6: SIZEOF (QUERY (lsc <* QUERY (pdr <* USEDIN (SELF,
    'PLANT_SPATIAL_CONFIGURATIONS.' +
    'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') |
    pdr.used_representation.name = 'line segment characteristics') |
    NOT (SIZEOF (QUERY (it <* lsc.used_representation.items |
    ('PLANT_SPATIAL_CONFIGURATIONS.MEASURE_REPRESENTATION_ITEM' IN
    TYPEOF (it)) AND
    (it.name = 'design pressure')) = 1))) = 0;
  WR7: SIZEOF (QUERY (lsc <* QUERY (pdr <* USEDIN (SELF,
    'PLANT_SPATIAL_CONFIGURATIONS.' +
    'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') |
    pdr.used_representation.name = 'line segment characteristics') |
    NOT (SIZEOF (QUERY (it <* lsc.used_representation.items |
    (SIZEOF (TYPEOF (it) *
    ['PLANT_SPATIAL_CONFIGURATIONS.MEASURE_REPRESENTATION_ITEM',
    'PLANT_SPATIAL_CONFIGURATIONS.' +
    'THERMODYNAMIC_TEMPERATURE_MEASURE_WITH_UNIT']) = 2) AND
    (it.name = 'design temperature')) = 1))) = 0;
  WR8: SIZEOF (QUERY (lsc <* QUERY (pdr <* USEDIN (SELF,
    'PLANT_SPATIAL_CONFIGURATIONS.' +

```

```

'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') |
pdr.used_representation.name = 'line segment characteristics') |
NOT (SIZEOF (QUERY (it <* lsc.used_representation.items |
(SIZEOF (TYPEOF (it) *
['PLANT_SPATIAL_CONFIGURATION.MEASURE_REPRESENTATION_ITEM',
'PLANT_SPATIAL_CONFIGURATION.LENGTH_MEASURE_WITH_UNIT'])) = 2) AND
(it.name = 'elevation')))) <= 1))) = 0;
WR9: SIZEOF (QUERY (lsc <* QUERY (pdr <* USEDIN (SELF,
'PLANT_SPATIAL_CONFIGURATION.' +
'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') |
pdr.used_representation.name = 'line segment characteristics') |
NOT (SIZEOF (QUERY (it <* lsc.used_representation.items |
('PLANT_SPATIAL_CONFIGURATION.MEASURE_REPRESENTATION_ITEM' IN
TYPEOF (it)) AND
(it.name = 'corrosion allowance')))) <= 1))) = 0;
WR10: (NOT (SIZEOF (QUERY (pdr <* USEDIN (SELF,
'PLANT_SPATIAL_CONFIGURATION.' +
'PRODUCT_DEFINITION_RELATIONSHIP.RELATED_PRODUCT_DEFINITION') |
pdr.name = 'segment insulation')) >= 1)) OR
(SIZEOF (QUERY (si <* QUERY (pdr <* USEDIN (SELF,
'PLANT_SPATIAL_CONFIGURATION.' +
'PRODUCT_DEFINITION_RELATIONSHIP.RELATED_PRODUCT_DEFINITION') |
pdr.name = 'segment insulation') |
NOT (SIZEOF (QUERY (pd <* USEDIN (si,
'PLANT_SPATIAL_CONFIGURATION.PROPERTY_DEFINITION.DEFINITION') |
NOT (SIZEOF (QUERY (pds <* QUERY (pdr <* USEDIN (pd,
'PLANT_SPATIAL_CONFIGURATION.' +
'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') |
'PLANT_SPATIAL_CONFIGURATION.PRODUCT_DEFINITION_SHAPE' IN
TYPEOF (pdr)) |
pds.used_representation.name =
'segment insulation characteristics')) = 1))) = 0))) = 0);
WR11: (NOT (SIZEOF (QUERY (pdr <* USEDIN (SELF,
'PLANT_SPATIAL_CONFIGURATION.' +
'PRODUCT_DEFINITION_RELATIONSHIP.RELATED_PRODUCT_DEFINITION') |
pdr.name = 'segment insulation')) >= 1)) OR
(SIZEOF (QUERY (si <* QUERY (pdr <* USEDIN (SELF,
'PLANT_SPATIAL_CONFIGURATION.' +
'PRODUCT_DEFINITION_RELATIONSHIP.RELATED_PRODUCT_DEFINITION') |
pdr.name = 'segment insulation') |
NOT (SIZEOF (QUERY (pd <* USEDIN (si,
'PLANT_SPATIAL_CONFIGURATION.PROPERTY_DEFINITION.DEFINITION') |
NOT (SIZEOF (QUERY (sic <* QUERY (pds <* QUERY (pdr <* USEDIN (pd,
'PLANT_SPATIAL_CONFIGURATION.' +
'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') |
'PLANT_SPATIAL_CONFIGURATION.PRODUCT_DEFINITION_SHAPE' IN
TYPEOF (pdr)) |
pds.used_representation.name =
'segment insulation characteristics') |
SIZEOF (sic.used_representation.items) >= 1)) = 1))) = 0))) = 0);
WR12: (NOT (SIZEOF (QUERY (pdr <* USEDIN (SELF,
'PLANT_SPATIAL_CONFIGURATION.' +
'PRODUCT_DEFINITION_RELATIONSHIP.RELATED_PRODUCT_DEFINITION') |
pdr.name = 'segment insulation')) >= 1)) OR
(SIZEOF (QUERY (si <* QUERY (pdr <* USEDIN (SELF,
'PLANT_SPATIAL_CONFIGURATION.' +
'PRODUCT_DEFINITION_RELATIONSHIP.RELATED_PRODUCT_DEFINITION') |
pdr.name = 'segment insulation') |
NOT (SIZEOF (QUERY (pd <* USEDIN (si,
'PLANT_SPATIAL_CONFIGURATION.PROPERTY_DEFINITION.DEFINITION') |
NOT (SIZEOF (QUERY (sic <* QUERY (pds <* QUERY (pdr <* USEDIN (pd,
'PLANT_SPATIAL_CONFIGURATION.' +
'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') |
'PLANT_SPATIAL_CONFIGURATION.PRODUCT_DEFINITION_SHAPE' IN
TYPEOF (pdr)) |
pds.used_representation.name =
'segment insulation characteristics') |
{1 <= SIZEOF (QUERY (it <* sic.used_representation.items |
(SIZEOF (TYPEOF (it) *
['PLANT_SPATIAL_CONFIGURATION.MEASURE_REPRESENTATION_ITEM',

```

```

        'PLANT_SPATIAL_CONFIGURATION.LENGTH_MEASURE_WITH_UNIT')) = 2) AND
        (it.name IN ['thickness', 'minimum thickness',
        'maximum thickness']))) <= 2}))) = 1))) = 0))) = 0));
WR13: (NOT (SIZEOF (QUERY (pdr <* USEDIN (SELF,
        'PLANT_SPATIAL_CONFIGURATION.' +
        'PRODUCT_DEFINITION_RELATIONSHIP.RELATED_PRODUCT_DEFINITION')) |
        pdr.name = 'segment insulation')) >= 1)) OR
        (SIZEOF (QUERY (si <* QUERY (pdr <* USEDIN (SELF,
        'PLANT_SPATIAL_CONFIGURATION.' +
        'PRODUCT_DEFINITION_RELATIONSHIP.RELATED_PRODUCT_DEFINITION')) |
        pdr.name = 'segment insulation')) |
        NOT (SIZEOF (QUERY (pd <* USEDIN (si,
        'PLANT_SPATIAL_CONFIGURATION.PROPERTY_DEFINITION.DEFINITION')) |
        NOT (SIZEOF (QUERY (sic <* QUERY (pds <* QUERY (pdr <* USEDIN (pd,
        'PLANT_SPATIAL_CONFIGURATION.' +
        'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION')) |
        'PLANT_SPATIAL_CONFIGURATION.PRODUCT_DEFINITION_SHAPE' IN
        TYPEOF (pdr)) |
        pds.used_representation.name =
        'segment insulation characteristics')) |
        SIZEOF (QUERY (it <* sic.used_representation.items |
        (SIZEOF (TYPEOF (it) *
        ['PLANT_SPATIAL_CONFIGURATION.MEASURE_REPRESENTATION_ITEM',
        'PLANT_SPATIAL_CONFIGURATION.LENGTH_MEASURE_WITH_UNIT'])) = 2) AND
        (it.name = 'thickness')) <= 1)) = 1))) = 0))) = 0));
WR14: (NOT (SIZEOF (QUERY (pdr <* USEDIN (SELF,
        'PLANT_SPATIAL_CONFIGURATION.' +
        'PRODUCT_DEFINITION_RELATIONSHIP.RELATED_PRODUCT_DEFINITION')) |
        pdr.name = 'segment insulation')) >= 1)) OR
        (SIZEOF (QUERY (si <* QUERY (pdr <* USEDIN (SELF,
        'PLANT_SPATIAL_CONFIGURATION.' +
        'PRODUCT_DEFINITION_RELATIONSHIP.RELATED_PRODUCT_DEFINITION')) |
        pdr.name = 'segment insulation')) |
        NOT (SIZEOF (QUERY (pd <* USEDIN (si,
        'PLANT_SPATIAL_CONFIGURATION.PROPERTY_DEFINITION.DEFINITION')) |
        NOT (SIZEOF (QUERY (sic <* QUERY (pds <* QUERY (pdr <* USEDIN (pd,
        'PLANT_SPATIAL_CONFIGURATION.' +
        'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION')) |
        'PLANT_SPATIAL_CONFIGURATION.PRODUCT_DEFINITION_SHAPE' IN
        TYPEOF (pdr)) |
        pds.used_representation.name =
        'segment insulation characteristics')) |
        SIZEOF (QUERY (it <* sic.used_representation.items |
        (SIZEOF (TYPEOF (it) *
        ['PLANT_SPATIAL_CONFIGURATION.MEASURE_REPRESENTATION_ITEM',
        'PLANT_SPATIAL_CONFIGURATION.LENGTH_MEASURE_WITH_UNIT'])) = 2) AND
        (it.name = 'minimum thickness')) <= 1)) = 1))) = 0))) = 0));
WR15: (NOT (SIZEOF (QUERY (pdr <* USEDIN (SELF,
        'PLANT_SPATIAL_CONFIGURATION.' +
        'PRODUCT_DEFINITION_RELATIONSHIP.RELATED_PRODUCT_DEFINITION')) |
        pdr.name = 'segment insulation')) >= 1)) OR
        (SIZEOF (QUERY (si <* QUERY (pdr <* USEDIN (SELF,
        'PLANT_SPATIAL_CONFIGURATION.' +
        'PRODUCT_DEFINITION_RELATIONSHIP.RELATED_PRODUCT_DEFINITION')) |
        pdr.name = 'segment insulation')) |
        NOT (SIZEOF (QUERY (pd <* USEDIN (si,
        'PLANT_SPATIAL_CONFIGURATION.PROPERTY_DEFINITION.DEFINITION')) |
        NOT (SIZEOF (QUERY (sic <* QUERY (pds <* QUERY (pdr <* USEDIN (pd,
        'PLANT_SPATIAL_CONFIGURATION.' +
        'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION')) |
        'PLANT_SPATIAL_CONFIGURATION.PRODUCT_DEFINITION_SHAPE' IN
        TYPEOF (pdr)) |
        pds.used_representation.name =
        'segment insulation characteristics')) |
        SIZEOF (QUERY (it <* sic.used_representation.items |
        (SIZEOF (TYPEOF (it) *
        ['PLANT_SPATIAL_CONFIGURATION.MEASURE_REPRESENTATION_ITEM',
        'PLANT_SPATIAL_CONFIGURATION.LENGTH_MEASURE_WITH_UNIT'])) = 2) AND
        (it.name = 'maximum thickness')) <= 1)) = 1))) = 0))) = 0));
WR16: (NOT (SIZEOF (QUERY (pdr <* USEDIN (SELF,

```

```

'PLANT_SPATIAL_CONFIGURATION.' +
'PRODUCT_DEFINITION_RELATIONSHIP.RELATED_PRODUCT_DEFINITION') |
pdr.name = 'segment insulation')) >= 1)) OR
(SIZEOF (QUERY (si <* QUERY (pdr <* USEDIN (SELF,
'PLANT_SPATIAL_CONFIGURATION.' +
'PRODUCT_DEFINITION_RELATIONSHIP.RELATED_PRODUCT_DEFINITION') |
pdr.name = 'segment insulation') |
NOT (SIZEOF (QUERY (pd <* USEDIN (si,
'PLANT_SPATIAL_CONFIGURATION.PROPERTY_DEFINITION.DEFINITION') |
NOT (SIZEOF (QUERY (sic <* QUERY (pds <* QUERY (pdr <* USEDIN (pd,
'PLANT_SPATIAL_CONFIGURATION.' +
'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') |
'PLANT_SPATIAL_CONFIGURATION.PRODUCT_DEFINITION_SHAPE' IN
TYPEOF (pdr)) |
pds.used_representation.name =
'segment insulation characteristics') |
SIZEOF (QUERY (it <* sic.used_representation.items |
('PLANT_SPATIAL_CONFIGURATION.DESCRPTIVE_REPRESENTATION_ITEM' IN
TYPEOF (it)) AND
(it.name = 'boundaries')))) <= 1)) = 1))) = 0))) = 0);
WR17: SIZEOF (QUERY (pds <* QUERY (pd <* USEDIN (SELF,
'PLANT_SPATIAL_CONFIGURATION.PROPERTY_DEFINITION.DEFINITION') |
'PLANT_SPATIAL_CONFIGURATION.PRODUCT_DEFINITION_SHAPE' IN
TYPEOF (pd)) |
NOT (SIZEOF (QUERY (sa <*USEDIN (pds,
'PLANT_SPATIAL_CONFIGURATION.SHAPE_ASPECT.OF_SHAPE') |
'PLANT_SPATIAL_CONFIGURATION.PLANT_LINE_SEGMENT_TERMINATION' IN
TYPEOF (sa))) = 2))) = 0;
END_ENTITY;
(*

```

#### Formal propositions:

**WR1:** A **plant\_line\_segment\_definition** shall be the **related\_product\_definition** in a **product\_definition\_relationship** that has a **relating\_product\_definition** that is a **plant\_line\_definition**.

**WR2:** A **plant\_line\_segment\_definition** shall be referenced by a **shape\_definition**.

**WR3:** A **plant\_line\_segment\_definition** shall have a **frame\_of\_reference\_name** of 'functional definition'.

**WR4:** A **plant\_line\_segment\_definition** shall have exactly one representation with the name of 'line segment characteristics'.

**WR5:** The representation of the **plant\_line\_segment\_definition** with the name of 'line segment characteristics' shall have at least two **representation\_items**.

**WR6:** The representation of the **plant\_line\_segment\_definition** with the name of 'line segment characteristics' shall have exactly one **representation\_item** that is of type **measure\_representation\_item** with a name of 'design pressure'.

**WR7:** The representation of the **plant\_line\_segment\_definition** with the name of 'line segment characteristics' shall have exactly one **representation\_item** that is of type **measure\_representation\_item** and **thermodynamic\_temperature\_measure\_with\_unit** with a name of 'design temperature'.

**WR8:** The representation of the **plant\_line\_segment\_definition** with the name of 'line segment characteristics' shall have at most one **representation\_item** that is of type **measure\_representation\_item** and **length\_measure\_with\_unit** with a name of 'elevation'.

**WR9:** The representation of the **plant\_line\_segment\_definition** with the name of 'line segment characteristics' shall have at most one **representation\_item** that is of type **measure\_representation\_item**.

**item** with a name of ‘corrosion allowance’.

**WR10:** If the **plant\_line\_segment\_definition** is related to a **product\_definition** as a ‘segment insulation’, the **product\_definition** shall have a **product\_definition\_shape** that has exactly one **representation** with the **name** of ‘segment insulation characteristics’.

**WR11:** If the **plant\_line\_segment\_definition** is related to a **product\_definition** as a ‘segment insulation’, the **product\_definition** shall have a **product\_definition\_shape** that has exactly one **representation** with the **name** of ‘segment insulation characteristics’ that has at least one **representation\_item**.

**WR12:** If the **plant\_line\_segment\_definition** is related to a **product\_definition** as a ‘segment insulation’, the **product\_definition** shall have a **product\_definition\_shape** that has exactly one **representation** with the **name** of ‘segment insulation characteristics’ that has one or two **representation\_items** of type **measure\_representation\_item** and **length\_measure\_with\_unit** with a **name** of ‘thickness’, ‘minimum thickness’, or ‘maximum thickness’.

**WR13:** If the **plant\_line\_segment\_definition** is related to a **product\_definition** as a ‘segment insulation’, the **product\_definition** shall have a **product\_definition\_shape** that has exactly one **representation** with the **name** of ‘segment insulation characteristics’ that has at most one **representation\_item** items of type **measure\_representation\_item** and **length\_measure\_with\_unit** with a **name** of ‘thickness’.

**WR14:** If the **plant\_line\_segment\_definition** is related to a **product\_definition** as a ‘segment insulation’, the **product\_definition** shall have a **product\_definition\_shape** that has exactly one **representation** with the **name** of ‘segment insulation characteristics’ that has at most one **representation\_item** items of type **measure\_representation\_item** and **length\_measure\_with\_unit** with a **name** of ‘minimum thickness’.

**WR15:** If the **plant\_line\_segment\_definition** is related to a **product\_definition** as a ‘segment insulation’, the **product\_definition** shall have a **product\_definition\_shape** that has exactly one **representation** with the **name** of ‘segment insulation characteristics’ that has at most one **representation\_item** items of type **measure\_representation\_item** and **length\_measure\_with\_unit** with a **name** of ‘maximum thickness’.

**WR16:** If the **plant\_line\_segment\_definition** is related to a **product\_definition** as a ‘segment insulation’, the **product\_definition** shall have a **product\_definition\_shape** that has exactly one **representation** with the **name** of ‘segment insulation characteristics’ that has at most one **representation\_item** items of type **descriptive\_representation\_item** with a **name** of ‘boundaries’.

#### Associated global rules:

The following global rules defined in this part of ISO 10303 apply to the **plant\_line\_segment\_definition** entity:

- **application\_context\_requires\_ap\_definition** (see 5.2.4.1);
- **dependent\_instantiable\_application\_context** (see 5.2.4.9);
- **dependent\_instantiable\_product\_definition\_context** (see 5.2.4.11);
- **product\_definition\_context\_name\_constraint** (see 5.2.4.13).

### 5.2.3.1.84 plant\_line\_segment\_termination

A **plant\_line\_segment\_termination** is a type of **shape\_aspect** that identifies the termination of a line segment.

EXPRESS specification:

```
*)
ENTITY plant_line_segment_termination
  SUBTYPE OF (shape_aspect);
WHERE
  WR1: ((SELF.description = 'piping line segment termination') AND
    ('PLANT_SPATIAL_CONFIGURATION.PLANT_LINE_SEGMENT_DEFINITION'
    IN TYPEOF (SELF.of_shape.definition))) XOR
    ((SELF.description = 'piping line termination') AND
    ('PLANT_SPATIAL_CONFIGURATION.PRODUCT_DEFINITION_RELATIONSHIP'
    IN TYPEOF (SELF.of_shape.definition)) AND
    ('PLANT_SPATIAL_CONFIGURATION.PLANT_LINE_SEGMENT_DEFINITION'
    IN TYPEOF (SELF.of_shape.definition.related_product_definition)) AND
    ('PLANT_SPATIAL_CONFIGURATION.PLANT_LINE_DEFINITION'
    IN TYPEOF (SELF.of_shape.definition.relying_product_definition)));
  WR2: SIZEOF (QUERY (sar <*
    USEDIN (SELF, 'PLANT_SPATIAL_CONFIGURATION.' +
    'SHAPE_ASPECT_RELATIONSHIP.RELATING_SHAPE_ASPECT') +
    USEDIN (SELF, 'PLANT_SPATIAL_CONFIGURATION.' +
    'SHAPE_ASPECT_RELATIONSHIP.RELATED_SHAPE_ASPECT') |
    NOT (SIZEOF (TYPEOF (sar) *
    ['PLANT_SPATIAL_CONFIGURATION.LINE_BRANCH_CONNECTION',
    'PLANT_SPATIAL_CONFIGURATION.LINE_PLANT_ITEM_CONNECTION',
    'PLANT_SPATIAL_CONFIGURATION.LINE_TERMINATION_CONNECTION'])
    = 1))) = 0;
  WR3: SIZEOF (QUERY (sar <*
    USEDIN (SELF, 'PLANT_SPATIAL_CONFIGURATION.' +
    'SHAPE_ASPECT_RELATIONSHIP.RELATED_SHAPE_ASPECT') |
    SIZEOF (TYPEOF (sar) *
    ['PLANT_SPATIAL_CONFIGURATION.LINE_BRANCH_CONNECTION',
    'PLANT_SPATIAL_CONFIGURATION.LINE_PLANT_ITEM_CONNECTION']) = 1)) = 1;
END_ENTITY;
(*
```

Formal propositions:

**WR1:** If a **plant\_line\_segment\_termination** is the termination of a piping line segment, it shall be an aspect of the shape of a **plant\_line\_segment\_definition**. If the **plant\_line\_segment\_termination** is the termination of a piping line, it shall be an aspect of the shape of a **product\_definition\_relationship** in which the related\_product\_definition is a **plant\_line\_segment\_definition** and the relating\_shape\_aspect is a **plant\_line\_definition**.

**WR2:** A **plant\_line\_segment\_termination** is the **relating\_shape\_aspect** or the **related\_shape\_aspect** in at least one **shape\_aspect\_relationship** that is a **line\_branch\_connection**, **line\_plant\_item\_connection**, or **line\_termination\_connection**.

**WR3:** A **plant\_line\_segment\_termination** is the related\_shape\_aspect in exactly one **shape\_aspect\_relationship** that is either a **line\_termination\_connection** or **line\_branch\_connection** or is the relating\_shape\_aspect in exactly one **line\_plant\_item\_connection**.

Associated global rules:

The following global rules defined in this part of ISO 10303 apply to the **plant\_line\_segment\_termination** entity:

- **application\_context\_requires\_ap\_definition** (see 5.2.4.1);
- **dependent\_instantiable\_application\_context** (see 5.2.4.9);
- **dependent\_instantiable\_product\_definition\_context** (see 5.2.4.11);
- **product\_definition\_context\_name\_constraint** (see 5.2.4.13).

### 5.2.3.1.85 **plant\_spatial\_configuration\_change\_assignment**

A **plant\_spatial\_configuration\_change\_assignment** assigns a **change\_action** to a set of one or more **change\_items**.

EXPRESS specification:

```
*)
ENTITY plant_spatial_configuration_change_assignment
  SUBTYPE OF (action_assignment);
  items : SET [1:?] OF change_item;
WHERE
  WR1: 'PLANT_SPATIAL_CONFIGURATION.CHANGE_ACTION'
    IN TYPEOF (SELF.assigned_action);
END_ENTITY;
(*
```

Attribute definitions:

**items:** the set of **change\_items** that an action is assigned to.

Formal propositions:

**WR1:** The assigned action shall be a **change\_action**.

Associated global rules:

The following global rules defined in this part of ISO 10303 apply to the **plant\_spatial\_configuration\_change\_assignment** entity:

- **change\_item\_requires\_creation\_date** (see 5.2.4.5);
- **change\_item\_requires\_id** (see 5.2.4.6).

### 5.2.3.1.86 **plant\_spatial\_configuration\_organization\_assignment**

A **plant\_spatial\_configuration\_organization\_assignment** assigns an **organization** to a set of one or more **catalogues**, **change\_actions**, **design\_projects**, **documents**, **plants**, **product\_definition\_formation**s, **product\_definition\_relationship**s, and **sites**.

EXPRESS specification:

```
*)
ENTITY plant_spatial_configuration_organization_assignment
  SUBTYPE OF (organization_assignment);
  items : SET [1:?] OF plant_spatial_configuration_organization_item;
WHERE
  WR1: plant_spatial_configuration_organization_correlation (SELF);
END_ENTITY;
(*
```

Attribute definitions:

**items:** the set of **catalogues**, **change\_actions**, **design\_projects**, **documents**, **plants**, **product\_definition\_formation**s, **product\_definition\_relationship**s, and **sites** that an **organization** is assigned to.

Formal propositions:

**WR1:** The **plant\_spatial\_configuration\_organization\_correlation** function that correlates roles of organizations to elements of product data shall be satisfied.

### 5.2.3.1.87 **plant\_spatial\_configuration\_person\_and\_organization\_assignment**

A **plant\_spatial\_configuration\_person\_and\_organization\_assignment** assigns a **person\_and\_organization** to a set of one or more **change\_items**, **plants**, and **sites**.

EXPRESS specification:

```

*)
ENTITY plant_spatial_configuration_person_and_organization_assignment
  SUBTYPE OF (person_and_organization_assignment);
  items : SET [1:?] OF
    plant_spatial_configuration_person_and_organization_item;
WHERE
  WR1: plant_spatial_configuration_person_and_organization_correlation
    (SELF);
END_ENTITY;
( *
```

Attribute definitions:

**items:** the set of **change\_items**, **plants**, and **sites** that a **person\_and\_organization** is assigned to.

Formal propositions:

**WR1:** The **plant\_spatial\_configuration\_person\_and\_organization\_correlation** function that correlates roles of persons and organizations to elements of product data shall be satisfied.

### 5.2.3.1.88 **plant\_spatial\_configuration\_person\_assignment**

A **plant\_spatial\_configuration\_person\_assignment** assigns a **person** to a set of one or more **documents**, **plants**, **product\_definition\_relationship**s, and **sites**.

EXPRESS specification:

```

*)
ENTITY plant_spatial_configuration_person_assignment
  SUBTYPE OF (person_assignment);
  items : SET [1:?] OF plant_spatial_configuration_person_item;
WHERE
  WR1: plant_spatial_configuration_person_correlation (SELF);
END_ENTITY;
( *
```

Attribute definitions:

**items:** the set of **documents**, **plants**, **product\_definition\_relationship**s, and **sites** that a **person** is

assigned to.

#### Formal propositions:

**WR1:** The **plant\_spatial\_configuration\_person\_correlation** function that correlates roles of persons to elements of product data shall be satisfied.

### 5.2.3.1.89 process\_capability

A **process\_capability** is a type of **property\_definition** that identifies the physical or chemical process that is, or is intended to be, carried out by a **plant**.

#### EXPRESS specification:

```
*)
ENTITY process_capability
  SUBTYPE OF (property_definition);
WHERE
  WR1: 'PLANT_SPATIAL_CONFIGURATION.PLANT' IN
    TYPEOF(SELF.definition\product_definition.formation.of_product);
  WR2: SIZEOF (QUERY (pdr <* USEDIN (SELF,
    'PLANT_SPATIAL_CONFIGURATION.PROPERTY_DEFINITION_REPRESENTATION.' +
    'DEFINITION') |
    (pdr.used_representation.name = 'production capacity') AND
    (NOT (SIZEOF (QUERY (it <* pdr.used_representation.items |
    ('PLANT_SPATIAL_CONFIGURATION.DESRIPTIVE_REPRESENTATION_ITEM'
    IN TYPEOF (it)) AND
    (it.name = 'production type')) = 1)))) = 0;
END_ENTITY;
( *
```

#### Formal propositions:

**WR1:** A **process\_capability** is a property of a **plant**.

**WR2:** The **representation** instances associated with a **process\_capability** shall have a name of 'production capacity' and shall contain exactly one **descriptive\_representation\_item** with a name of 'production type'.

### 5.2.3.1.90 purchase\_assignment

A **purchase\_assignment** assigns a set of one or more **products** to an **action** to identify that the **product** is purchased.

#### EXPRESS specification:

```
*)
ENTITY purchase_assignment
  SUBTYPE OF (action_assignment);
  items : SET [1:?] OF purchase_item;
END_ENTITY;
( *
```

#### Attribute definitions:

**items:** the set of **products** that are purchased.

### 5.2.3.1.91 reducer\_fitting\_class

A **reducer\_fitting\_class** is a type of **group** that classifies the items that are assigned to it as reducer fittings.

EXPRESS specification:

```
*)
ENTITY reducer_fitting_class
  SUBTYPE OF (group);
WHERE
  WR1: SIZEOF (QUERY (aca <* QUERY (ca <* USEDIN (SELF,
    'PLANT_SPATIAL_CONFIGURATION.CLASSIFICATION_ASSIGNMENT.' +
    'ASSIGNED_CLASS') |
    'PLANT_SPATIAL_CONFIGURATION.APPLIED_CLASSIFICATION_ASSIGNMENT' IN
    TYPEOF (ca)) |
    NOT (SIZEOF (QUERY (it <* aca.items |
      NOT ('PLANT_SPATIAL_CONFIGURATION.PIPING_COMPONENT_DEFINITION' IN
        TYPEOF (it)))) = 0))) = 0;
  WR2: SIZEOF (QUERY (aca <* QUERY (ca <* USEDIN (SELF,
    'PLANT_SPATIAL_CONFIGURATION.CLASSIFICATION_ASSIGNMENT.' +
    'ASSIGNED_CLASS') |
    'PLANT_SPATIAL_CONFIGURATION.APPLIED_CLASSIFICATION_ASSIGNMENT' IN
    TYPEOF (ca)) |
    NOT (SIZEOF (QUERY (pcd <* QUERY (it <* aca.items |
      'PLANT_SPATIAL_CONFIGURATION.PIPING_COMPONENT_DEFINITION' IN
      TYPEOF (it)) |
      NOT (SIZEOF (QUERY (acal <* USEDIN (pcd.formation.of_product,
        'PLANT_SPATIAL_CONFIGURATION.' +
        'APPLIED_CLASSIFICATION_ASSIGNMENT.ITEMS') |
        class_in_tree (acal.assigned_class, 'reducer'))
        = 1))) = 0))) = 0;
END_ENTITY;
(*
```

Formal propositions:

**WR1:** A **reducer\_fitting\_class** shall classify items of type **pipng\_component\_definition**.

**WR2:** A **reducer\_fitting\_class** shall classify items of type **pipng\_component\_definition** that are a definition of a **product** that is categorized as a 'reducer'.

### 5.2.3.1.92 reference\_geometry

A **reference\_geometry** is a type of **derived\_shape\_aspect** that is a geometric element that is not part of the definition of the shape of **plant\_item**, but is provided as supplementary geometric information. A **reference\_geometry** has a relationship to the shape definition geometry and may be derivable from shape geometry.

EXAMPLE Centrelines of symmetric elements and origin points are considered **reference\_geometry**.

EXPRESS specification:

```
*)
ENTITY reference_geometry
  SUBTYPE OF (derived_shape_aspect);
WHERE
  WR1: SIZEOF (QUERY (pd <* USEDIN (SELF, 'PLANT_SPATIAL_CONFIGURATION.' +
    'PROPERTY_DEFINITION.DEFINITION') |
    NOT (SIZEOF (USEDIN (pd, 'PLANT_SPATIAL_CONFIGURATION.' +
    'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION')) >= 1))) = 0;
END_ENTITY;
```

( \*

#### Formal propositions:

**WR1:** Each **reference\_geometry** shall have at least one **representation**.

### 5.2.3.1.93 reinforcing\_component\_definition

A **reinforcing\_component\_definition** is a type of **product\_definition** that defines a reinforcing component.

#### EXPRESS specification

```
*)
ENTITY reinforcing_component_definition
  SUBTYPE OF (product_definition);
END_ENTITY;
( *
```

### 5.2.3.1.94 required\_material\_property

A **required\_material\_property** is a type of **material\_property** that specifies the material or the requirements for the material that a plant item should be made from.

#### EXPRESS specification:

```
*)
ENTITY required_material_property
  SUBTYPE OF (material_property);
WHERE
  WR1: (SIZEOF (TYPEOF (SELF\property_definition.definition) *
    ['PLANT_SPATIAL_CONFIGURATION.PLANT_ITEM_CONNECTOR',
    'PLANT_SPATIAL_CONFIGURATION.' +
    'EXTERNALLY_DEFINED_PLANT_ITEM_DEFINITION']) = 1) OR
    (('PLANT_SPATIAL_CONFIGURATION.PRODUCT_DEFINITION' IN
    TYPEOF (SELF.definition)) AND
    (SIZEOF (QUERY (pc <* SELF\property_definition.
    definition\product_definition.formation.of_product.
    frame_of_reference |
    pc.discipline_type = 'process plant')) = 1));
  WR2: SIZEOF (QUERY (ra <* QUERY (pdr <* USEDIN (SELF,
    'PLANT_SPATIAL_CONFIGURATION.' +
    'PROPERTY_DEFINITION_RELATIONSHIP.RELATED_PROPERTY_DEFINITION') |
    pdr.name = 'requirement allocation') |
    'PLANT_SPATIAL_CONFIGURATION.MATERIAL_PROPERTY' IN
    TYPEOF (ra.relating_property_definition))) >= 1;
END_ENTITY;
( *
```

#### Formal propositions:

**WR1:** A **required\_material\_property** shall be a property of a **plant\_item\_connector**, **externally\_defined\_plant\_item**, or a **product\_definition** that defines a plant item.

**WR2:** A **required\_material\_property** shall be related to at least one **material\_property** as the 'requirement allocation'.

### 5.2.3.1.95 reserved\_space

A **reserved\_space** is a type of **shape\_aspect** that identifies a space that is reserved for a plant item.

```

*)
ENTITY reserved_space
  SUBTYPE OF (shape_aspect);
WHERE
  WR1: SELF\shape_aspect.of_shape\property_definition.
        definition\product_definition.
        frame_of_reference\application_context_element.name =
        'physical occurrence';
END_ENTITY;
( *

```

#### Formal propositions:

**WR1:** A **reserved\_space** shall be an aspect of the definition of the shape of a **product\_definition** with a context with the name 'physical occurrence'.

#### Associated global rules:

The following global rules defined in this part of ISO 10303 apply to the **reserved\_space** entity:

- **application\_context\_requires\_ap\_definition** (see 5.2.4.1);
- **dependent\_instantiable\_application\_context** (see 5.2.4.9);
- **dependent\_instantiable\_product\_definition\_context** (see 5.2.4.11);
- **product\_definition\_context\_name\_constraint** (see 5.2.4.13);
- **product\_definition\_usage\_constraint** (see 5.2.4.14).

### 5.2.3.1.96 site

A **site** is a type of **characterized\_object** and **property\_definition** that identifies the geographic and topographic characteristics of the location of a plant.

#### EXPRESS specification:

```

*)
ENTITY site
  SUBTYPE OF (characterized_object, property_definition);
WHERE
  WR1: 'PLANT_SPATIAL_CONFIGURATION.PLANT' IN
        TYPEOF (SELF\property_definition.definition\product_definition.
        formation.of_product);
END_ENTITY;
( *

```

#### Formal propositions:

**WR1:** Each **site** shall be a property of a **plant**.

#### Associated global rule:

The following global rule defined in this part of ISO 10303 applies to the **site** entity:

- **subtype\_exclusive\_characterized\_object** (see 5.2.4.15)

### 5.2.3.1.97 site\_building

A **site\_building** is a type of **property\_definition** that identifies a partially or totally enclosed structure located on a site.

#### EXPRESS specification:

```

*)
ENTITY site_building
  SUBTYPE OF (property_definition);
WHERE
  WR1: 'PLANT_SPATIAL_CONFIGURATION.SITE' IN
        TYPEOF (SELF.definition);
  WR2: SIZEOF (QUERY (pdr <* USEDIN (SELF,
        'PLANT_SPATIAL_CONFIGURATION.' +
        'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') |
        (pdr.used_representation.name = 'building number') AND
        (SIZEOF (QUERY (it <* pdr.used_representation.items |
        ('PLANT_SPATIAL_CONFIGURATION.DESRIPTIVE_REPRESENTATION_ITEM' IN
        TYPEOF (it)))) = 1))) = 1);
  WR3: SIZEOF (QUERY (pdr <* USEDIN (SELF,
        'PLANT_SPATIAL_CONFIGURATION.' +
        'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') |
        SIZEOF (QUERY (it <* pdr.used_representation.items |
        (SIZEOF ([ 'PLANT_SPATIAL_CONFIGURATION.AXIS2_PLACEMENT_2D',
        'PLANT_SPATIAL_CONFIGURATION.AXIS2_PLACEMENT_3D'] *
        TYPEOF (it)) = 1) AND
        (it.name = 'building orientation') AND
        (it.location.name = 'building location')) = 1)) <= 1;
END_ENTITY;
(*

```

#### Formal propositions:

**WR1:** A **site\_building** shall be a property of a site.

**WR2:** The **site\_building** shall have exactly one **representation** with a name of 'building number' that contains exactly one **representation\_item** that is a **descriptive\_representation\_item**.

**WR3:** The **site\_building** shall have at most one **representation** that contains exactly one **axis2\_placement\_2d** or **axis2\_placement\_3d** with a **name** of 'building orientation' and a **location** that has a **name** of 'building location'.

### 5.2.3.1.98 site\_feature

A **site\_feature** is a type of **property\_definition** that identifies the composition, proportions, form or outward appearance of part of a site.

#### EXPRESS specification:

```

*)
ENTITY site_feature
  SUBTYPE OF (property_definition);
WHERE
  WR1: 'PLANT_SPATIAL_CONFIGURATION.SITE' IN
        TYPEOF (SELF.definition);
  WR2: SIZEOF (USEDIN (SELF, 'PLANT_SPATIAL_CONFIGURATION.' +
        'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION')) = 3;
  WR3: SIZEOF (QUERY (pdr <* USEDIN (SELF,
        'PLANT_SPATIAL_CONFIGURATION.' +
        'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') |
        SIZEOF (QUERY (it <* pdr.used_representation.items |

```

```

        ('PLANT_SPATIAL_CONFIGURATION.DESCRPTIVE_REPRESENTATION_ITEM' IN
        TYPEOF (it)) AND
        (it.name = 'site feature type')) = 1)) = 1;
WR4: SIZEOF (QUERY (pdr <* USEDIN (SELF,
        'PLANT_SPATIAL_CONFIGURATION.' +
        'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') |
        SIZEOF (QUERY (it <* pdr.used_representation.items |
        (SIZEOF ([ 'PLANT_SPATIAL_CONFIGURATION.AXIS2_PLACEMENT_2D',
        'PLANT_SPATIAL_CONFIGURATION.AXIS2_PLACEMENT_3D'] *
        TYPEOF (it)) = 1) AND
        (it.name = 'feature orientation') AND
        (it.location.name = 'feature location')))) = 1)) = 1;
WR5: SIZEOF (QUERY (pdr <* USEDIN (SELF,
        'PLANT_SPATIAL_CONFIGURATION.' +
        'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') |
        SIZEOF (QUERY (it <* pdr.used_representation.items |
        ('PLANT_SPATIAL_CONFIGURATION.DESCRPTIVE_REPRESENTATION_ITEM' IN
        TYPEOF (pdr.used_representation)) AND
        (it.name = 'origin type') AND
        (it.description IN ['man made', 'natural']))) = 1)) = 1;
END_ENTITY;
( *

```

#### Formal propositions:

**WR1:** A **site\_feature** is a property of a **site**.

**WR2:** A **site\_feature** is referenced by exactly three **property\_definition\_representation** instances.

**WR3:** A **site\_feature** shall have exactly one **representation** contains exactly one item of type **descriptive\_representation\_item** with the name of 'site feature type'.

**WR4:** The **site\_feature** shall have at exactly one **representation** that contains exactly one **axis2\_placement\_2d** or **axis2\_placement\_3d** with a **name** of 'feature orientation' and a **location** that has a **name** of 'feature location'.

**WR5:** The **site\_feature** shall have exactly one **representation** that contains exactly one **representation\_item** that is a **descriptive\_representation\_item** with the name of 'origin type' and a **description** of either 'man made' or 'natural'.

### 5.2.3.1.99 site\_representation

A **site\_representation** is a type of **shape\_representation** that represents the shape properties of a **site**.

#### EXPRESS specification:

```

*)
ENTITY site_representation
  SUBTYPE OF (shape_representation);
WHERE
  WR1: SIZEOF (QUERY (pdr <* USEDIN (SELF, 'PLANT_SPATIAL_CONFIGURATION.' +
    'PROPERTY_DEFINITION_REPRESENTATION.USED_REPRESENTATION') |
    NOT('PLANT_SPATIAL_CONFIGURATION.SITE' IN
    TYPEOF (pdr.definition.definition)))) = 0;
  WR2: SIZEOF (QUERY (item <* SELF.items |
    NOT (SIZEOF ([ 'PLANT_SPATIAL_CONFIGURATION.CONNECTED_FACE_SET',
    'PLANT_SPATIAL_CONFIGURATION.GEOMETRIC_CURVE_SET'] *
    TYPEOF (item)) = 1))) = 1;
  WR3: SIZEOF (QUERY (cfs <* QUERY (item <* SELF.items |
    'PLANT_SPATIAL_CONFIGURATION.CONNECTED_FACE_SET' IN TYPEOF (item)) |
    NOT (SIZEOF (QUERY (fcs <* cfs\connected_face_set.cfs_faces |
    NOT (SIZEOF (QUERY (bnds <* fcs.bounds |
    NOT ('PLANT_SPATIAL_CONFIGURATION.POLY_LOOP'

```

```

        IN TYPEOF (bnds.bound))))
        = 0))) = 0))) = 0;
WR4: SIZEOF (QUERY (cfs <* QUERY (item <* SELF.items |
        'PLANT_SPATIAL_CONFIGURATION.CONNECTED_FACE_SET' IN TYPEOF (item)) |
        NOT (SIZEOF (QUERY (fcs <* cfs\connected_face_set.cfs_faces |
        NOT (SIZEOF (QUERY (bnds <* fcs.bound |
        NOT (SIZEOF (bnds.bound\poly_loop.polygon) = 3)))
        = 0))) = 0))) = 0;
WR5: SIZEOF (QUERY (gcs <* QUERY (item <* SELF.items |
        'PLANT_SPATIAL_CONFIGURATION.GEOMETRIC_CURVE_SET'
        IN TYPEOF (item)) |
        NOT (SIZEOF (QUERY (el <* gcs\geometric_set.elements |
        NOT (SIZEOF ([ 'PLANT_SPATIAL_CONFIGURATION.CARTESIAN_POINT',
        'PLANT_SPATIAL_CONFIGURATION.POLYLINE'] * TYPEOF (el))
        = 1))) = 0))) = 0;
WR6: SIZEOF (QUERY (gcs <* QUERY (item <* SELF.items |
        'PLANT_SPATIAL_CONFIGURATION.GEOMETRIC_CURVE_SET'
        IN TYPEOF (item)) |
        NOT (SIZEOF (QUERY (el <* gcs\geometric_set.elements |
        'PLANT_SPATIAL_CONFIGURATION.CARTESIAN_POINT' IN TYPEOF (el))
        >= 1))) = 0;
WR7: SIZEOF (QUERY (gcs <* QUERY (item <* SELF.items |
        'PLANT_SPATIAL_CONFIGURATION.GEOMETRIC_CURVE_SET'
        IN TYPEOF (item)) |
        NOT (SIZEOF (QUERY (pline <* QUERY (el <*
        gcs\geometric_set.elements |
        'PLANT_SPATIAL_CONFIGURATION.POLYLINE' IN TYPEOF (el)) |
        NOT (SIZEOF (QUERY (pline_pt <* pline\polyline.points |
        NOT (pline_pt IN gcs\geometric_set.elements))) = 0))) = 0))) = 0;
END_ENTITY;
(*

```

#### Formal propositions:

**WR1:** A **site\_representation** shall be used to represent a **site**.

**WR2:** A **site\_representation** shall have in its set of items exactly one **connected\_face\_set** or **geometric\_curve\_set**.

**WR3:** If the **representation\_item** is a **connected\_face\_set**, it shall contain faces that are bounded by **poly\_loops**.

**WR4:** If the **representation\_item** is a **connected\_face\_set**, all of its **face** instances shall be bounded by **poly\_loops** with topology defined by three **cartesian\_points**.

**WR5:** If the **representation\_item** is a **geometric\_curve\_set**, its **elements** set shall consist of **cartesian\_point** or **polyline**.

**WR6:** If the **representation\_item** is a **geometric\_curve\_set**, its **elements** shall consist of at least one **cartesian\_point**.

**WR7:** If the **representation\_item** is a **geometric\_curve\_set**, its **elements** that are of type **polyline** shall reference only points that are in the **elements** set.

#### Associated global rule:

The following global rule defined in this part of ISO 10303 applies to the **site\_representation** entity:

- **subtype\_mandatory\_shape\_representation** (see 5.2.4.18)

### 5.2.3.1.100 sited\_plant

A **sited\_plant** is a type of **property\_definition** that specifies a plant that is located on a site. The location need not be specified.

#### EXPRESS specification:

```
*)
ENTITY sited_plant
  SUBTYPE OF (property_definition);
UNIQUE
  UR1: SELF\property_definition.definition;
WHERE
  WR1: 'PLANT_SPATIAL_CONFIGURATION.PRODUCT_DEFINITION' IN TYPEOF
    (SELF.definition);
  WR2: SELF.definition.frame_of_reference.name = 'physical occurrence';
END_ENTITY;
(*
```

#### Formal propositions:

**UR1:** Each **sited\_plant** shall be related to zero or one **characterized\_definition**.

**WR1:** A **sited\_plant** shall be the property of a **product\_definition**.

**WR2:** A **sited\_plant** shall be the property of a **product\_definition** that is a physical occurrence.

### 5.2.3.1.101 spacer\_fitting\_class

A **spacer\_fitting\_class** is a type of **group** that classifies the items that are assigned to it as spacer fittings.

#### EXPRESS specification:

```
*)
ENTITY spacer_fitting_class
  SUBTYPE OF (group);
WHERE
  WR1: SIZEOF (QUERY (aca <* QUERY (ca <* USEDIN (SELF,
    'PLANT_SPATIAL_CONFIGURATION.CLASSIFICATION_ASSIGNMENT.' +
    'ASSIGNED_CLASS') |
    'PLANT_SPATIAL_CONFIGURATION.APPLIED_CLASSIFICATION_ASSIGNMENT' IN
    TYPEOF (ca)) |
    NOT (SIZEOF (QUERY (it <* aca.items |
    NOT ('PLANT_SPATIAL_CONFIGURATION.PIPING_COMPONENT_DEFINITION' IN
    TYPEOF (it)))) = 0))) = 0;
  WR2: SIZEOF (QUERY (aca <* QUERY (ca <* USEDIN (SELF,
    'PLANT_SPATIAL_CONFIGURATION.CLASSIFICATION_ASSIGNMENT.' +
    'ASSIGNED_CLASS') |
    'PLANT_SPATIAL_CONFIGURATION.APPLIED_CLASSIFICATION_ASSIGNMENT' IN
    TYPEOF (ca)) |
    NOT (SIZEOF (QUERY (pcd <* QUERY (it <* aca.items |
    'PLANT_SPATIAL_CONFIGURATION.PIPING_COMPONENT_DEFINITION' IN
    TYPEOF (it)) |
    NOT (SIZEOF (QUERY (acal <* USEDIN (pcd.formation.of_product,
    'PLANT_SPATIAL_CONFIGURATION.' +
    'APPLIED_CLASSIFICATION_ASSIGNMENT.ITEMS') |
    class_in_tree (acal.assigned_class, 'spacer'))
    = 1))) = 0))) = 0;
END_ENTITY;
(*
```

Formal propositions:

**WR1:** A **spacer\_fitting\_class** shall classify items of type **piping\_component\_definition**.

**WR2:** A **spacer\_fitting\_class** shall classify items of type **piping\_component\_definition** that are a definition of a **product** that is categorized as a 'spacer'.

### 5.2.3.1.102 specialty\_item\_class

A **specialty\_item\_class** is a type of **group** that classifies the items are assigned to it as specialty items. The name of the **specialty\_item\_class** may further classify the assigned items.

EXPRESS specification:

```
*)
ENTITY specialty_item_class
  SUBTYPE OF (group);
END_ENTITY;
(*
```

### 5.2.3.1.103 stream\_design\_case

A **stream\_design\_case** is a type of **property\_definition** and **characterized\_object** that identifies the characteristics of a gas, liquid, vapour, or particulate stream.

EXPRESS specification:

```
*)
ENTITY stream_design_case
  SUBTYPE OF (property_definition, characterized_object);
WHERE
  WR1: SIZEOF (QUERY (pd <* USEDIN (SELF, 'PLANT_SPATIAL_CONFIGURATION.' +
    'PROPERTY_DEFINITION.DEFINITION') |
    'PLANT_SPATIAL_CONFIGURATION.STREAM_PHASE' IN
    TYPEOF (pd))) >= 1;
  WR2: SIZEOF (QUERY (pdr <* USEDIN (SELF, 'PLANT_SPATIAL_CONFIGURATION.' +
    'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') |
    pdr.used_representation.name = 'stream flow characteristics')) = 1;
  WR3: SIZEOF (QUERY (sfc <* QUERY (pdr <* USEDIN (SELF,
    'PLANT_SPATIAL_CONFIGURATION.' +
    'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') |
    pdr.used_representation.name = 'stream flow characteristics') |
    NOT (SIZEOF (sfc.used_representation.items) >= 2))) = 0;
  WR4: SIZEOF (QUERY (sfc <* QUERY (pdr <* USEDIN (SELF,
    'PLANT_SPATIAL_CONFIGURATION.' +
    'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') |
    pdr.used_representation.name = 'stream flow characteristics') |
    NOT ({1 <= SIZEOF (QUERY (it <* sfc.used_representation.items |
    ('PLANT_SPATIAL_CONFIGURATION.MEASURE_REPRESENTATION_ITEM' IN
    TYPEOF (it)) AND
    (it.name IN ['flow rate', 'minimum flow rate',
    'maximum flow rate']))) <= 2}))) = 0;
  WR5: SIZEOF (QUERY (sfc <* QUERY (pdr <* USEDIN (SELF,
    'PLANT_SPATIAL_CONFIGURATION.' +
    'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') |
    pdr.used_representation.name = 'stream flow characteristics') |
    NOT (SIZEOF (QUERY (it <* sfc.used_representation.items |
    ('PLANT_SPATIAL_CONFIGURATION.MEASURE_REPRESENTATION_ITEM' IN
    TYPEOF (it)) AND
    (it.name = 'flow rate')))) <= 1))) = 0;
  WR6: SIZEOF (QUERY (sfc <* QUERY (pdr <* USEDIN (SELF,
    'PLANT_SPATIAL_CONFIGURATION.' +
    'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') |
```

```

pdr.used_representation.name = 'stream flow characteristics') |
NOT (SIZEOF (QUERY (it <* sfc.used_representation.items |
('PLANT_SPATIAL_CONFIGURATION.MEASURE_REPRESENTATION_ITEM' IN
TYPEOF (it)) AND
(it.name = 'minimum flow rate')))) <= 1))) = 0;
WR7: SIZEOF (QUERY (sfc <* QUERY (pdr <* USEDIN (SELF,
'PLANT_SPATIAL_CONFIGURATION.' +
'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') |
pdr.used_representation.name = 'stream flow characteristics') |
NOT (SIZEOF (QUERY (it <* sfc.used_representation.items |
('PLANT_SPATIAL_CONFIGURATION.MEASURE_REPRESENTATION_ITEM' IN
TYPEOF (it)) AND
(it.name = 'maximum flow rate')))) <= 1))) = 0;
WR8: SIZEOF (QUERY (sfc <* QUERY (pdr <* USEDIN (SELF,
'PLANT_SPATIAL_CONFIGURATION.' +
'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') |
pdr.used_representation.name = 'stream flow characteristics') |
NOT ({1 <= SIZEOF (QUERY (it <* sfc.used_representation.items |
('PLANT_SPATIAL_CONFIGURATION.MEASURE_REPRESENTATION_ITEM' IN
TYPEOF (it)) AND
(it.name IN ['pressure', 'minimum pressure',
'maximum pressure']))) <= 2}))) = 0;
WR9: SIZEOF (QUERY (sfc <* QUERY (pdr <* USEDIN (SELF,
'PLANT_SPATIAL_CONFIGURATION.' +
'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') |
pdr.used_representation.name = 'stream flow characteristics') |
NOT (SIZEOF (QUERY (it <* sfc.used_representation.items |
('PLANT_SPATIAL_CONFIGURATION.MEASURE_REPRESENTATION_ITEM' IN
TYPEOF (it)) AND
(it.name = 'pressure')))) <= 1))) = 0;
WR10: SIZEOF (QUERY (sfc <* QUERY (pdr <* USEDIN (SELF,
'PLANT_SPATIAL_CONFIGURATION.' +
'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') |
pdr.used_representation.name = 'stream flow characteristics') |
NOT (SIZEOF (QUERY (it <* sfc.used_representation.items |
('PLANT_SPATIAL_CONFIGURATION.MEASURE_REPRESENTATION_ITEM' IN
TYPEOF (it)) AND
(it.name = 'minimum pressure')))) <= 1))) = 0;
WR11: SIZEOF (QUERY (sfc <* QUERY (pdr <* USEDIN (SELF,
'PLANT_SPATIAL_CONFIGURATION.' +
'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') |
pdr.used_representation.name = 'stream flow characteristics') |
NOT (SIZEOF (QUERY (it <* sfc.used_representation.items |
('PLANT_SPATIAL_CONFIGURATION.MEASURE_REPRESENTATION_ITEM' IN
TYPEOF (it)) AND
(it.name = 'maximum pressure')))) <= 1))) = 0;
WR12: SIZEOF (QUERY (sfc <* QUERY (pdr <* USEDIN (SELF,
'PLANT_SPATIAL_CONFIGURATION.' +
'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') |
pdr.used_representation.name = 'stream flow characteristics') |
NOT (SIZEOF (QUERY (it <* sfc.used_representation.items |
('PLANT_SPATIAL_CONFIGURATION.DESCRPTIVE_REPRESENTATION_ITEM' IN
TYPEOF (it)) AND
(it.name = 'stream data reference')))) <= 1))) = 0;
WR13: (NOT (SIZEOF (QUERY (pdr <* USEDIN (SELF,
'PLANT_SPATIAL_CONFIGURATION.' +
'PROPERTY_DEFINITION_RELATIONSHIP.RELATING_PROPERTY_DEFINITION') |
pdr.related_property_definition.name =
'service characteristics')) >= 1)) OR
(SIZEOF (QUERY (sc <* QUERY (pdr <* USEDIN (SELF,
'PLANT_SPATIAL_CONFIGURATION.' +
'PROPERTY_DEFINITION_RELATIONSHIP.RELATING_PROPERTY_DEFINITION') |
pdr.related_property_definition.name =
'service characteristics') |
NOT (SIZEOF (QUERY (pdr <* USEDIN (sc.related_property_definition,
'PLANT_SPATIAL_CONFIGURATION.' +
'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') |
pdr.used_representation.name =
'service operating characteristics')) = 1))) = 0);
WR14: (NOT (SIZEOF (QUERY (pdr <* USEDIN (SELF,

```

```

'PLANT_SPATIAL_CONFIGURATION.' +
'PROPERTY_DEFINITION_RELATIONSHIP.RELATING_PROPERTY_DEFINITION') |
pdr.related_property_definition.name =
'service characteristics')) >= 1)) OR
(SIZEOF (QUERY (sc <* QUERY (pdr <* USEDIN (SELF,
'PLANT_SPATIAL_CONFIGURATION.' +
'PROPERTY_DEFINITION_RELATIONSHIP.RELATING_PROPERTY_DEFINITION') |
pdr.related_property_definition.name =
'service characteristics') |
NOT (SIZEOF (QUERY (soc <* QUERY (pdr <*
USEDIN (sc.related_property_definition,
'PLANT_SPATIAL_CONFIGURATION.' +
'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') |
pdr.used_representation.name =
'service operating characteristics') |
NOT (SIZEOF (soc.used_representation.items) >= 3))) = 0))) = 0));
WR15: (NOT (SIZEOF (QUERY (pdr <* USEDIN (SELF,
'PLANT_SPATIAL_CONFIGURATION.' +
'PROPERTY_DEFINITION_RELATIONSHIP.RELATING_PROPERTY_DEFINITION') |
pdr.related_property_definition.name =
'service characteristics')) >= 1)) OR
(SIZEOF (QUERY (sc <* QUERY (pdr <* USEDIN (SELF,
'PLANT_SPATIAL_CONFIGURATION.' +
'PROPERTY_DEFINITION_RELATIONSHIP.RELATING_PROPERTY_DEFINITION') |
pdr.related_property_definition.name = 'service characteristics') |
NOT (SIZEOF (QUERY (soc <* QUERY (pdr <*
USEDIN (sc.related_property_definition,
'PLANT_SPATIAL_CONFIGURATION.' +
'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') |
pdr.used_representation.name =
'service operating characteristics') |
{1 <= SIZEOF (QUERY (it <* soc.used_representation.items |
(SIZEOF (TYPEOF (it) *
['PLANT_SPATIAL_CONFIGURATION.MEASURE_REPRESENTATION_ITEM',
'PLANT_SPATIAL_CONFIGURATION.' +
'THERMODYNAMIC_TEMPERATURE_MEASURE_WITH_UNIT']) = 2) AND
(it.name IN ['temperature', 'minimum temperature',
'maximum temperature']) <= 2})) = 1))) = 0));
WR16: (NOT (SIZEOF (QUERY (pdr <* USEDIN (SELF,
'PLANT_SPATIAL_CONFIGURATION.' +
'PROPERTY_DEFINITION_RELATIONSHIP.RELATING_PROPERTY_DEFINITION') |
pdr.related_property_definition.name =
'service characteristics')) >= 1)) OR
(SIZEOF (QUERY (sc <* QUERY (pdr <* USEDIN (SELF,
'PLANT_SPATIAL_CONFIGURATION.' +
'PROPERTY_DEFINITION_RELATIONSHIP.RELATING_PROPERTY_DEFINITION') |
pdr.related_property_definition.name = 'service characteristics') |
NOT (SIZEOF (QUERY (soc <* QUERY (pdr <*
USEDIN (sc.related_property_definition,
'PLANT_SPATIAL_CONFIGURATION.' +
'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') |
pdr.used_representation.name =
'service operating characteristics') |
SIZEOF (QUERY (it <* soc.used_representation.items |
(SIZEOF (TYPEOF (it) *
['PLANT_SPATIAL_CONFIGURATION.MEASURE_REPRESENTATION_ITEM',
'PLANT_SPATIAL_CONFIGURATION.' +
'THERMODYNAMIC_TEMPERATURE_MEASURE_WITH_UNIT']) = 2) AND
(it.name = 'temperature')) <= 1)) = 1))) = 0));
WR17: (NOT (SIZEOF (QUERY (pdr <* USEDIN (SELF,
'PLANT_SPATIAL_CONFIGURATION.' +
'PROPERTY_DEFINITION_RELATIONSHIP.RELATING_PROPERTY_DEFINITION') |
pdr.related_property_definition.name =
'service characteristics')) >= 1)) OR
(SIZEOF (QUERY (sc <* QUERY (pdr <* USEDIN (SELF,
'PLANT_SPATIAL_CONFIGURATION.' +
'PROPERTY_DEFINITION_RELATIONSHIP.RELATING_PROPERTY_DEFINITION') |
pdr.related_property_definition.name = 'service characteristics') |
NOT (SIZEOF (QUERY (soc <* QUERY (pdr <*
USEDIN (sc.related_property_definition,

```

```

'PLANT_SPATIAL_CONFIGURATION.' +
'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') |
pdr.used_representation.name =
'service operating characteristics') |
SIZEOF (QUERY (it <* soc.used_representation.items |
(SIZEOF (TYPEOF (it) *
['PLANT_SPATIAL_CONFIGURATION.MEASURE_REPRESENTATION_ITEM',
'PLANT_SPATIAL_CONFIGURATION.' +
'THERMODYNAMIC_TEMPERATURE_MEASURE_WITH_UNIT']) = 2) AND
(it.name = 'minimum temperature')))) <= 1)) = 1))) = 0);
WR18: (NOT (SIZEOF (QUERY (pdr <* USEDIN (SELF,
'PLANT_SPATIAL_CONFIGURATION.' +
'PROPERTY_DEFINITION_RELATIONSHIP.RELATING_PROPERTY_DEFINITION') |
pdr.related_property_definition.name =
'service characteristics')) >= 1)) OR
(SIZEOF (QUERY (sc <* QUERY (pdr <* USEDIN (SELF,
'PLANT_SPATIAL_CONFIGURATION.' +
'PROPERTY_DEFINITION_RELATIONSHIP.RELATING_PROPERTY_DEFINITION') |
pdr.related_property_definition.name = 'service characteristics')) |
NOT (SIZEOF (QUERY (soc <* QUERY (pdr <*
USEDIN (sc.related_property_definition,
'PLANT_SPATIAL_CONFIGURATION.' +
'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') |
pdr.used_representation.name =
'service operating characteristics') |
SIZEOF (QUERY (it <* soc.used_representation.items |
(SIZEOF (TYPEOF (it) *
['PLANT_SPATIAL_CONFIGURATION.MEASURE_REPRESENTATION_ITEM',
'PLANT_SPATIAL_CONFIGURATION.' +
'THERMODYNAMIC_TEMPERATURE_MEASURE_WITH_UNIT']) = 2) AND
(it.name = 'maximum temperature')))) <= 1)) = 1))) = 0);
WR19: (NOT (SIZEOF (QUERY (pdr <* USEDIN (SELF,
'PLANT_SPATIAL_CONFIGURATION.' +
'PROPERTY_DEFINITION_RELATIONSHIP.RELATING_PROPERTY_DEFINITION') |
pdr.related_property_definition.name =
'service characteristics')) >= 1)) OR
(SIZEOF (QUERY (sc <* QUERY (pdr <* USEDIN (SELF,
'PLANT_SPATIAL_CONFIGURATION.' +
'PROPERTY_DEFINITION_RELATIONSHIP.RELATING_PROPERTY_DEFINITION') |
pdr.related_property_definition.name = 'service characteristics')) |
NOT (SIZEOF (QUERY (soc <* QUERY (pdr <*
USEDIN (sc.related_property_definition,
'PLANT_SPATIAL_CONFIGURATION.' +
'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') |
pdr.used_representation.name =
'service operating characteristics') |
{1 <= SIZEOF (QUERY (it <* soc.used_representation.items |
('PLANT_SPATIAL_CONFIGURATION.MEASURE_REPRESENTATION_ITEM' IN
TYPEOF (it)) AND
(it.name IN ['pressure', 'minimum pressure',
'maximum pressure']))) <= 2}))) = 1))) = 0);
WR20: (NOT (SIZEOF (QUERY (pdr <* USEDIN (SELF,
'PLANT_SPATIAL_CONFIGURATION.' +
'PROPERTY_DEFINITION_RELATIONSHIP.RELATING_PROPERTY_DEFINITION') |
pdr.related_property_definition.name =
'service characteristics')) >= 1)) OR
(SIZEOF (QUERY (sc <* QUERY (pdr <* USEDIN (SELF,
'PLANT_SPATIAL_CONFIGURATION.' +
'PROPERTY_DEFINITION_RELATIONSHIP.RELATING_PROPERTY_DEFINITION') |
pdr.related_property_definition.name = 'service characteristics')) |
NOT (SIZEOF (QUERY (soc <* QUERY (pdr <*
USEDIN (sc.related_property_definition,
'PLANT_SPATIAL_CONFIGURATION.' +
'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') |
pdr.used_representation.name =
'service operating characteristics') |
SIZEOF (QUERY (it <* soc.used_representation.items |
('PLANT_SPATIAL_CONFIGURATION.MEASURE_REPRESENTATION_ITEM' IN
TYPEOF (it)) AND
(it.name = 'pressure')))) <= 1)) = 1))) = 0);

```

```

WR21: (NOT (SIZEOF (QUERY (pdr <* USEDIN (SELF,
'PLANT_SPATIAL_CONFIGURATION.' +
'PROPERTY_DEFINITION_RELATIONSHIP.RELATING_PROPERTY_DEFINITION')) |
pdr.related_property_definition.name =
'service characteristics')) >= 1)) OR
(SIZEOF (QUERY (sc <* QUERY (pdr <* USEDIN (SELF,
'PLANT_SPATIAL_CONFIGURATION.' +
'PROPERTY_DEFINITION_RELATIONSHIP.RELATING_PROPERTY_DEFINITION')) |
pdr.related_property_definition.name = 'service characteristics')) |
NOT (SIZEOF (QUERY (soc <* QUERY (pdr <*
USEDIN (sc.related_property_definition,
'PLANT_SPATIAL_CONFIGURATION.' +
'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION')) |
pdr.used_representation.name =
'service operating characteristics')) |
SIZEOF (QUERY (it <* soc.used_representation.items |
('PLANT_SPATIAL_CONFIGURATION.MEASURE_REPRESENTATION_ITEM' IN
TYPEOF (it)) AND
(it.name = 'minimum pressure')))) <= 1)) = 1))) = 0);

WR22: (NOT (SIZEOF (QUERY (pdr <* USEDIN (SELF,
'PLANT_SPATIAL_CONFIGURATION.' +
'PROPERTY_DEFINITION_RELATIONSHIP.RELATING_PROPERTY_DEFINITION')) |
pdr.related_property_definition.name =
'service characteristics')) >= 1)) OR
(SIZEOF (QUERY (sc <* QUERY (pdr <* USEDIN (SELF,
'PLANT_SPATIAL_CONFIGURATION.' +
'PROPERTY_DEFINITION_RELATIONSHIP.RELATING_PROPERTY_DEFINITION')) |
pdr.related_property_definition.name = 'service characteristics')) |
NOT (SIZEOF (QUERY (soc <* QUERY (pdr <*
USEDIN (sc.related_property_definition,
'PLANT_SPATIAL_CONFIGURATION.' +
'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION')) |
pdr.used_representation.name =
'service operating characteristics')) |
SIZEOF (QUERY (it <* soc.used_representation.items |
('PLANT_SPATIAL_CONFIGURATION.MEASURE_REPRESENTATION_ITEM' IN
TYPEOF (it)) AND
(it.name = 'maximum pressure')))) <= 1)) = 1))) = 0);

WR23: (NOT (SIZEOF (QUERY (pdr <* USEDIN (SELF,
'PLANT_SPATIAL_CONFIGURATION.' +
'PROPERTY_DEFINITION_RELATIONSHIP.RELATING_PROPERTY_DEFINITION')) |
pdr.related_property_definition.name =
'service characteristics')) >= 1)) OR
(SIZEOF (QUERY (sc <* QUERY (pdr <* USEDIN (SELF,
'PLANT_SPATIAL_CONFIGURATION.' +
'PROPERTY_DEFINITION_RELATIONSHIP.RELATING_PROPERTY_DEFINITION')) |
pdr.related_property_definition.name = 'service characteristics')) |
NOT (SIZEOF (QUERY (soc <* QUERY (pdr <*
USEDIN (sc.related_property_definition,
'PLANT_SPATIAL_CONFIGURATION.' +
'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION')) |
pdr.used_representation.name =
'service operating characteristics')) |
{1 <= SIZEOF (QUERY (it <* soc.used_representation.items |
(SIZEOF (TYPEOF (it) *
['PLANT_SPATIAL_CONFIGURATION.MEASURE_REPRESENTATION_ITEM',
'PLANT_SPATIAL_CONFIGURATION.TIME_MEASURE_WITH_UNIT']) = 2) AND
(it.name IN ['duration', 'minimum duration',
'maximum duration'])})) <= 2})) = 1))) = 0);

WR24: (NOT (SIZEOF (QUERY (pdr <* USEDIN (SELF,
'PLANT_SPATIAL_CONFIGURATION.' +
'PROPERTY_DEFINITION_RELATIONSHIP.RELATING_PROPERTY_DEFINITION')) |
pdr.related_property_definition.name =
'service characteristics')) >= 1)) OR
(SIZEOF (QUERY (sc <* QUERY (pdr <* USEDIN (SELF,
'PLANT_SPATIAL_CONFIGURATION.' +
'PROPERTY_DEFINITION_RELATIONSHIP.RELATING_PROPERTY_DEFINITION')) |
pdr.related_property_definition.name = 'service characteristics')) |
NOT (SIZEOF (QUERY (soc <* QUERY (pdr <*
USEDIN (sc.related_property_definition,

```

```

'PLANT_SPATIAL_CONFIGURATION.' +
'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') |
pdr.used_representation.name =
'service operating characteristics') |
SIZEOF (QUERY (it <* soc.used_representation.items |
(SIZEOF (TYPEOF (it) *
['PLANT_SPATIAL_CONFIGURATION.MEASURE_REPRESENTATION_ITEM',
'PLANT_SPATIAL_CONFIGURATION.TIME_MEASURE_WITH_UNIT']) = 2) AND
(it.name = 'duration')))) <= 1)) = 1))) = 0);
WR25: (NOT (SIZEOF (QUERY (pdr <* USEDIN (SELF,
'PLANT_SPATIAL_CONFIGURATION.' +
'PROPERTY_DEFINITION_RELATIONSHIP.RELATING_PROPERTY_DEFINITION') |
pdr.related_property_definition.name =
'service characteristics')) >= 1)) OR
(SIZEOF (QUERY (sc <* QUERY (pdr <* USEDIN (SELF,
'PLANT_SPATIAL_CONFIGURATION.' +
'PROPERTY_DEFINITION_RELATIONSHIP.RELATING_PROPERTY_DEFINITION') |
pdr.related_property_definition.name = 'service characteristics') |
NOT (SIZEOF (QUERY (soc <* QUERY (pdr <*
USEDIN (sc.related_property_definition,
'PLANT_SPATIAL_CONFIGURATION.' +
'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') |
pdr.used_representation.name =
'service operating characteristics') |
SIZEOF (QUERY (it <* soc.used_representation.items |
(SIZEOF (TYPEOF (it) *
['PLANT_SPATIAL_CONFIGURATION.MEASURE_REPRESENTATION_ITEM',
'PLANT_SPATIAL_CONFIGURATION.TIME_MEASURE_WITH_UNIT']) = 2) AND
(it.name = 'minimum duration')))) <= 1)) = 1))) = 0);
WR26: (NOT (SIZEOF (QUERY (pdr <* USEDIN (SELF,
'PLANT_SPATIAL_CONFIGURATION.' +
'PROPERTY_DEFINITION_RELATIONSHIP.RELATING_PROPERTY_DEFINITION') |
pdr.related_property_definition.name =
'service characteristics')) >= 1)) OR
(SIZEOF (QUERY (sc <* QUERY (pdr <* USEDIN (SELF,
'PLANT_SPATIAL_CONFIGURATION.' +
'PROPERTY_DEFINITION_RELATIONSHIP.RELATING_PROPERTY_DEFINITION') |
pdr.related_property_definition.name = 'service characteristics') |
NOT (SIZEOF (QUERY (soc <* QUERY (pdr <*
USEDIN (sc.related_property_definition,
'PLANT_SPATIAL_CONFIGURATION.' +
'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') |
pdr.used_representation.name =
'service operating characteristics') |
SIZEOF (QUERY (it <* soc.used_representation.items |
(SIZEOF (TYPEOF (it) *
['PLANT_SPATIAL_CONFIGURATION.MEASURE_REPRESENTATION_ITEM',
'PLANT_SPATIAL_CONFIGURATION.TIME_MEASURE_WITH_UNIT']) = 2) AND
(it.name = 'maximum duration')))) <= 1)) = 1))) = 0);
WR27: (NOT (SIZEOF (QUERY (pdr <* USEDIN (SELF,
'PLANT_SPATIAL_CONFIGURATION.' +
'PROPERTY_DEFINITION_RELATIONSHIP.RELATING_PROPERTY_DEFINITION') |
pdr.related_property_definition.name =
'service characteristics')) >= 1)) OR
(SIZEOF (QUERY (sc <* QUERY (pdr <* USEDIN (SELF,
'PLANT_SPATIAL_CONFIGURATION.' +
'PROPERTY_DEFINITION_RELATIONSHIP.RELATING_PROPERTY_DEFINITION') |
pdr.related_property_definition.name = 'service characteristics') |
NOT ('PLANT_SPATIAL_CONFIGURATION.PLANT_ITEM_CONNECTOR' IN
TYPEOF (sc.related_property_definition.definition)))) = 0);
END_ENTITY;
(*

```

### Formal propositions:

**WR1:** A **stream\_design\_case** shall have at least one **stream\_phase**.

**WR2:** A **stream\_design\_case** shall have exactly one representation with the **name** of 'stream flow

characteristics’.

**WR3:** The representation of the **stream\_design\_case** with the **name** of ‘stream flow characteristics’ shall have at least two **representation\_items**.

**WR4:** The representation of the **stream\_design\_case** with the **name** of ‘stream flow characteristics’ shall have between one and two **representation\_items** that are of type **measure\_representation\_item** with a name of ‘flow rate’, ‘maximum flow rate’, or ‘minimum flow rate’.

**WR5:** The representation of the **stream\_design\_case** with the **name** of ‘stream flow characteristics’ shall have at most one **representation\_item** that is of type **measure\_representation\_item** with a name of ‘flow rate’.

**WR6:** The representation of the **stream\_design\_case** with the **name** of ‘stream flow characteristics’ shall have at most one **representation\_item** that is of type **measure\_representation\_item** with a name of ‘minimum flow rate’.

**WR7:** The representation of the **stream\_design\_case** with the **name** of ‘stream flow characteristics’ shall have at most one **representation\_item** that is of type **measure\_representation\_item** with a name of ‘maximum flow rate’.

**WR8:** The representation of the **stream\_design\_case** with the **name** of ‘stream flow characteristics’ shall have between one and two **representation\_items** that are of type **measure\_representation\_item** with a name of ‘pressure’, ‘maximum pressure’, or ‘minimum pressure’.

**WR9:** The representation of the **stream\_design\_case** with the **name** of ‘stream flow characteristics’ shall have at most one **representation\_item** that is of type **measure\_representation\_item** with a name of ‘pressure’.

**WR10:** The representation of the **stream\_design\_case** with the **name** of ‘stream flow characteristics’ shall have at most one **representation\_item** that is of type **measure\_representation\_item** with a name of ‘minimum pressure’.

**WR11:** The representation of the **stream\_design\_case** with the **name** of ‘stream flow characteristics’ shall have at most one **representation\_item** that is of type **measure\_representation\_item** with a name of ‘maximum pressure’.

**WR12:** The representation of the **stream\_design\_case** with the **name** of ‘stream flow characteristics’ shall have at most one **representation\_item** that is of type **descriptive\_representation\_item** with a name of ‘stream reference data’.

**WR13:** If the **stream\_design\_case** relates to a **property\_definition** with a **name** of ‘service characteristics’, the **property\_definition** that is related with a **name** of ‘service characteristics’ shall have exactly one **representation** with the **name** of ‘stream operating characteristics’.

**WR14:** If the **stream\_design\_case** relates to a **property\_definition** with a **name** of ‘service characteristics’, the **representation** with the **name** of ‘stream operating characteristics’ of that **property\_definition** shall have at least three **representation\_items**.

**WR15:** If the **stream\_design\_case** relates to a **property\_definition** with a **name** of ‘service characteristics’, the **representation** with the **name** of ‘stream operating characteristics’ of that **property\_definition** shall have one or two **representation\_items** of type **measure\_representation\_item** and **thermodynamic\_temperature\_measure\_with\_unit** with a **name** of ‘temperature’, ‘minimum

temperature', or 'maximum temperature'.

**WR16:** If the **stream\_design\_case** relates to a **property\_definition** with a **name** of 'services characteristics', the **representation** with the **name** of 'stream operating characteristics' of that **property\_definition** shall have at most one **representation\_item** of type **measure\_representation\_item** and **thermodynamic\_temperature\_measure\_with\_unit** with a **name** of 'temperature'.

**WR17:** If the **stream\_design\_case** relates to a **property\_definition** with a **name** of 'service characteristics', the **representation** with the **name** of 'stream operating characteristics' of that **property\_definition** shall have at most one **representation\_item** of type **measure\_representation\_item** and **thermodynamic\_temperature\_measure\_with\_unit** with a **name** of 'minimum temperature'.

**WR18:** If the **stream\_design\_case** relates to a **property\_definition** with a **name** of 'service characteristics', the **representation** with the **name** of 'stream operating characteristics' of that **property\_definition** shall have at most one **representation\_item** of type **measure\_representation\_item** and **thermodynamic\_temperature\_measure\_with\_unit** with a **name** of 'maximum temperature'.

**WR19:** If the **stream\_design\_case** relates to a **property\_definition** with a **name** of 'service characteristics', the **representation** with the **name** of 'stream operating characteristics' of that **property\_definition** shall have one or two **representation\_items** of type **measure\_representation\_item** with a **name** of 'pressure', 'minimum pressure', or 'maximum pressure'.

**WR20:** If the **stream\_design\_case** relates to a **property\_definition** with a **name** of 'service characteristics', the **representation** with the **name** of 'stream operating characteristics' of that **property\_definition** shall have at most one **representation\_item** of type **measure\_representation\_item** with a **name** of 'pressure'.

**WR21:** If the **stream\_design\_case** relates to a **property\_definition** with a **name** of 'service characteristics', the **representation** with the **name** of 'stream operating characteristics' of that **property\_definition** shall have at most one **representation\_item** of type **measure\_representation\_item** with a **name** of 'minimum pressure'.

**WR22:** If the **stream\_design\_case** relates to a **property\_definition** with a **name** of 'service characteristics', the **representation** with the **name** of 'stream operating characteristics' of that **property\_definition** shall have at most one **representation\_item** of type **measure\_representation\_item** with a **name** of 'maximum pressure'.

**WR23:** If the **stream\_design\_case** relates to a **property\_definition** with a **name** of 'service characteristics', the **representation** with the **name** of 'stream operating characteristics' of that **property\_definition** shall have one or two **representation\_items** of type **measure\_representation\_item** and **time\_measure\_with\_unit** with a **name** of 'duration', 'minimum duration', or 'maximum duration'.

**WR24:** If the **stream\_design\_case** relates to a **property\_definition** with a **name** of 'service characteristics', the **representation** with the **name** of 'stream operating characteristics' of that **property\_definition** shall have at most one **representation\_item** of type **measure\_representation\_item** and **time\_measure\_with\_unit** with a **name** of 'duration'.

**WR25:** If the **stream\_design\_case** relates to a **property\_definition** with a **name** of 'service characteristics', the **representation** with the **name** of 'stream operating characteristics' of that **property\_definition** shall have at most one **representation\_item** of type **measure\_representation\_item** and **time\_measure\_with\_unit** with a **name** of 'minimum duration'.

**WR26:** If the **stream\_design\_case** relates to a **property\_definition** with a **name** of 'service characteristics', the **representation** with the **name** of 'stream operating characteristics' of that

**property\_definition** shall have at most one **representation\_item** of type **measure\_representation\_item** and **time\_measure\_with\_unit** with a **name** of 'maximum duration'.

**WR27:** If the **stream\_design\_case** relates to a **property\_definition** with a **name** of 'service characteristics', that **property\_definition** shall be a property of a **plant\_item\_connector**.

Associated global rule:

The following global rule defined in this part of ISO 10303 applies to the **stream\_design\_case** entity:

- **subtype\_exclusive\_characterized\_object** (see 5.2.4.15)

### 5.2.3.1.104 stream\_phase

A **stream\_phase** is a type of **property\_definition** that identifies the characteristics of a gas, liquid, vapour, or particulate phase.

EXPRESS specification:

```

*)
ENTITY stream_phase
  SUBTYPE OF (property_definition);
WHERE
  WR1: 'PLANT_SPATIAL_CONFIGURATION.STREAM_DESIGN_CASE' IN
        TYPEOF (SELF.DEFINITION);
  WR2: SIZEOF (QUERY (pdr <* USEDIN (SELF, 'PLANT_SPATIAL_CONFIGURATION.' +
        'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') |
        pdr.used_representation.name = 'stream phase characteristics')) = 1;
  WR3: SIZEOF (QUERY (spc <* QUERY (pdr <* USEDIN (SELF,
        'PLANT_SPATIAL_CONFIGURATION.' +
        'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') |
        pdr.used_representation.name = 'stream phase characteristics') |
        NOT (SIZEOF (spc.used_representation.items) >= 5))) = 0;
  WR4: SIZEOF (QUERY (spc <* QUERY (pdr <* USEDIN (SELF,
        'PLANT_SPATIAL_CONFIGURATION.' +
        'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') |
        pdr.used_representation.name = 'stream phase characteristics') |
        NOT (SIZEOF (QUERY (it <* spc.used_representation.items |
        (SIZEOF (TYPEOF (it) *
        ['PLANT_SPATIAL_CONFIGURATION.MEASURE_REPRESENTATION_ITEM',
        'PLANT_SPATIAL_CONFIGURATION.RATIO_MEASURE_WITH_UNIT']) = 2) AND
        (it.name = 'constituent mole fraction')) = 1))) = 0;
  WR5: SIZEOF (QUERY (spc <* QUERY (pdr <* USEDIN (SELF,
        'PLANT_SPATIAL_CONFIGURATION.' +
        'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') |
        pdr.used_representation.name = 'stream phase characteristics') |
        NOT (SIZEOF (QUERY (it <* spc.used_representation.items |
        ('PLANT_SPATIAL_CONFIGURATION.DESCRPTIVE_REPRESENTATION_ITEM' IN
        TYPEOF (it)) AND
        (it.name = 'constituents')) = 1))) = 0;
  WR6: SIZEOF (QUERY (spc <* QUERY (pdr <* USEDIN (SELF,
        'PLANT_SPATIAL_CONFIGURATION.' +
        'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') |
        pdr.used_representation.name = 'stream phase characteristics') |
        NOT (SIZEOF (QUERY (it <* spc.used_representation.items |
        ('PLANT_SPATIAL_CONFIGURATION.MEASURE_REPRESENTATION_ITEM' IN
        TYPEOF (it)) AND
        (it.name = 'phase density')) = 1))) = 0;
  WR7: SIZEOF (QUERY (spc <* QUERY (pdr <* USEDIN (SELF,
        'PLANT_SPATIAL_CONFIGURATION.' +
        'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') |
        pdr.used_representation.name = 'stream phase characteristics') |
        NOT (SIZEOF (QUERY (it <* spc.used_representation.items |
        (SIZEOF (TYPEOF (it) *

```

```

[ 'PLANT_SPATIAL_CONFIGURATION.MEASURE_REPRESENTATION_ITEM',
  'PLANT_SPATIAL_CONFIGURATION.RATIO_MEASURE_WITH_UNIT']] = 2) AND
(it.name = 'phase fraction')))) = 1))) = 0;
WR8: SIZEOF (QUERY (spc <* QUERY (pdr <* USEDIN (SELF,
  'PLANT_SPATIAL_CONFIGURATION.' +
  'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION')) |
  pdr.used_representation.name = 'stream phase characteristics') |
  NOT ({1 <= SIZEOF (QUERY (it <* spc.used_representation.items |
    (SIZEOF (TYPEOF (it) *
    ['PLANT_SPATIAL_CONFIGURATION.MEASURE_REPRESENTATION_ITEM',
     'PLANT_SPATIAL_CONFIGURATION.' +
     'THERMODYNAMIC_TEMPERATURE_MEASURE_WITH_UNIT']] = 2) AND
    (it.name IN ['temperature', 'minimum temperature',
     'maximum temperature']))) <= 2}))) = 0;
WR9: SIZEOF (QUERY (spc <* QUERY (pdr <* USEDIN (SELF,
  'PLANT_SPATIAL_CONFIGURATION.' +
  'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION')) |
  pdr.used_representation.name = 'stream phase characteristics') |
  NOT (SIZEOF (QUERY (it <* spc.used_representation.items |
    (SIZEOF (TYPEOF (it) *
    ['PLANT_SPATIAL_CONFIGURATION.MEASURE_REPRESENTATION_ITEM',
     'PLANT_SPATIAL_CONFIGURATION.' +
     'THERMODYNAMIC_TEMPERATURE_MEASURE_WITH_UNIT']] = 2) AND
    (it.name = 'temperature')))) <= 1))) = 0;
WR10: SIZEOF (QUERY (spc <* QUERY (pdr <* USEDIN (SELF,
  'PLANT_SPATIAL_CONFIGURATION.' +
  'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION')) |
  pdr.used_representation.name = 'stream phase characteristics') |
  NOT (SIZEOF (QUERY (it <* spc.used_representation.items |
    (SIZEOF (TYPEOF (it) *
    ['PLANT_SPATIAL_CONFIGURATION.MEASURE_REPRESENTATION_ITEM',
     'PLANT_SPATIAL_CONFIGURATION.' +
     'THERMODYNAMIC_TEMPERATURE_MEASURE_WITH_UNIT']] = 2) AND
    (it.name = 'minimum temperature')))) <= 1))) = 0;
WR11: SIZEOF (QUERY (spc <* QUERY (pdr <* USEDIN (SELF,
  'PLANT_SPATIAL_CONFIGURATION.' +
  'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION')) |
  pdr.used_representation.name = 'stream phase characteristics') |
  NOT (SIZEOF (QUERY (it <* spc.used_representation.items |
    (SIZEOF (TYPEOF (it) *
    ['PLANT_SPATIAL_CONFIGURATION.MEASURE_REPRESENTATION_ITEM',
     'PLANT_SPATIAL_CONFIGURATION.' +
     'THERMODYNAMIC_TEMPERATURE_MEASURE_WITH_UNIT']] = 2) AND
    (it.name = 'maximum temperature')))) <= 1))) = 0;
WR12: SIZEOF (QUERY (spc <* QUERY (pdr <* USEDIN (SELF,
  'PLANT_SPATIAL_CONFIGURATION.' +
  'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION')) |
  pdr.used_representation.name = 'stream phase characteristics') |
  NOT (SIZEOF (QUERY (it <* spc.used_representation.items |
    ('PLANT_SPATIAL_CONFIGURATION.MEASURE_REPRESENTATION_ITEM' IN
    TYPEOF (it)) AND
    (it.name = 'specific gravity')))) <= 1))) = 0;
WR13: SIZEOF (QUERY (spc <* QUERY (pdr <* USEDIN (SELF,
  'PLANT_SPATIAL_CONFIGURATION.' +
  'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION')) |
  pdr.used_representation.name = 'stream phase characteristics') |
  NOT (SIZEOF (QUERY (it <* spc.used_representation.items |
    ('PLANT_SPATIAL_CONFIGURATION.MEASURE_REPRESENTATION_ITEM' IN
    TYPEOF (it)) AND
    (it.name = 'surface tension')))) <= 1))) = 0;
WR14: SIZEOF (QUERY (spc <* QUERY (pdr <* USEDIN (SELF,
  'PLANT_SPATIAL_CONFIGURATION.' +
  'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION')) |
  pdr.used_representation.name = 'stream phase characteristics') |
  NOT (SIZEOF (QUERY (it <* spc.used_representation.items |
    ('PLANT_SPATIAL_CONFIGURATION.MEASURE_REPRESENTATION_ITEM' IN
    TYPEOF (it)) AND
    (it.name = 'viscosity')))) <= 1))) = 0;
END_ENTITY;
(*

```

Formal propositions:

**WR1:** A **stream\_phase** shall define a property of a **stream\_design\_case**.

**WR2:** A **stream\_phase** shall have exactly one **representation** with the name of ‘stream phase characteristics’.

**WR3:** The representation of the **stream\_phase** with the name of ‘stream phase characteristics’ shall have at least five **representation\_items**.

**WR4:** The representation of the **stream\_phase** with the name of ‘stream phase characteristics’ shall have exactly one **representation\_item** that is of type **measure\_representation\_item** and **ratio\_measure\_-with\_unit** with a name of ‘constituent mole fraction’.

**WR5:** The representation of the **stream\_phase** with the name of ‘stream phase characteristics’ shall have exactly one **representation\_item** that is of type **descriptive\_representation\_item** with a name of ‘constituents’.

**WR6:** The representation of the **stream\_phase** with the name of ‘stream phase characteristics’ shall have exactly one **representation\_item** that is of type **measure\_representation\_item** with a name of ‘phase density’.

**WR7:** The representation of the **stream\_phase** with the name of ‘stream phase characteristics’ shall have exactly one **representation\_item** that is of type **measure\_representation\_item** and **ratio\_measure\_-with\_unit** with a name of ‘phase fraction’.

**WR8:** The representation of the **stream\_phase** with the name of ‘stream phase characteristics’ shall have one or two **representation\_items** of type **measure\_representation\_item** and **thermodynamic\_-temperature\_measure\_with\_unit** with a name of ‘temperature’, ‘minimum temperature’, or ‘maximum temperature’.

**WR9:** The representation of the **stream\_phase** with the name of ‘stream phase characteristics’ shall have at most one **representation\_item** of type **measure\_representation\_item** and **thermodynamic\_-temperature\_measure\_with\_unit** with a name of ‘temperature’.

**WR10:** The representation of the **stream\_phase** with the name of ‘stream phase characteristics’ shall have at most one **representation\_item** of type **measure\_representation\_item** and **thermodynamic\_-temperature\_measure\_with\_unit** with a name of ‘minimum temperature’.

**WR11:** The representation of the **stream\_phase** with the name of ‘stream phase characteristics’ shall have at most one **representation\_item** of type **measure\_representation\_item** and **thermodynamic\_-temperature\_measure\_with\_unit** with a name of ‘maximum temperature’.

**WR12:** The representation of the **stream\_phase** with the name of ‘stream phase characteristics’ shall have at most one **representation\_item** that is of type **measure\_representation\_item** with a name of ‘specific gravity’.

**WR13:** The representation of the **stream\_phase** with the name of ‘stream phase characteristics’ shall have at most one **representation\_item** that is of type **measure\_representation\_item** with a name of ‘surface tension’.

**WR14:** The representation of the **stream\_phase** with the name of ‘stream phase characteristics’ shall have at most one **representation\_item** that is of type **measure\_representation\_item** with a name of

‘viscosity’.

### 5.2.3.1.105 structural\_load\_connector\_class

A **structural\_load\_connector\_class** is a type of **group** that classifies the items that are assigned to it as being structural load connectors. The **name** of the **structural\_connector\_class** further classifies the assigned items.

EXPRESS specification:

```
*)
ENTITY structural_load_connector_class
  SUBTYPE OF (group);
END_ENTITY;
( *
```

### 5.2.3.1.106 structural\_system

A **structural\_system** is a type of **product\_definition** that identifies a system or assembly of structural components.

EXPRESS specification:

```
*)
ENTITY structural_system
  SUBTYPE OF (product_definition);
WHERE
  WR1: SIZEOF (QUERY (pdr <* USEDIN (SELF, 'PLANT_SPATIAL_CONFIGURATION.' +
    'PRODUCT_DEFINITION_RELATIONSHIP.RELATED_PRODUCT_DEFINITION') |
    ('PLANT_SPATIAL_CONFIGURATION.PLANT' IN TYPEOF
    (pdr.relate_product_definition.formation.of_product)) AND
    (pdr.relate_product_definition.frame_of_reference.name =
    'functional occurrence')))) = 1;
END_ENTITY;
( *
```

Formal propositions:

**WR1:** The **structural\_system** shall be related to exactly one **product\_definition** that is the definition of a plant and has a context of ‘functional occurrence’.

### 5.2.3.1.107 support\_constraint\_representation

A **support\_constraint\_representation** is a type of **representation** that identifies limitations on the movement of a plant item.

EXPRESS specification:

```
*)
ENTITY support_constraint_representation
  SUBTYPE OF (representation);
WHERE
  WR1: SIZEOF (SELF.items) >= 3;
  WR2: SIZEOF (QUERY (it <* SELF.items |
    ('PLANT_SPATIAL_CONFIGURATION.MEASURE_REPRESENTATION_ITEM'
    IN TYPEOF (it)) AND
    (it.name IN ['negative x', 'positive x', 'negative y',
    'positive y', 'negative z', 'positive z',
    'negative x rotation', 'positive x rotation',
    'negative y rotation', 'positive y rotation',
```

```

        'negative z rotation', 'positive z rotation'] ))) = 1;
WR3: SIZEOF (QUERY (it <* SELF.items |
        'PLANT_SPATIAL_CONFIGURATION.RATIO_MEASURE_WITH_UNIT'
        IN TYPEOF (it))) = 1;
WR4: SIZEOF (QUERY (it <* SELF.items |
        'PLANT_SPATIAL_CONFIGURATION.DESCRPTIVE_REPRESENTATION_ITEM'
        IN TYPEOF (it))) = 1;
END_ENTITY;
(*

```

#### Formal propositions:

**WR1:** The **support\_constraint\_representation** shall contain at least three items.

**WR2:** The **support\_constraint\_representation** shall contain **measure\_representation\_items** that have a name of 'negative x', 'positive x', 'negative y', 'positive y', 'negative z', 'positive z', 'negative x rotation', 'positive x rotation', 'negative y rotation', 'positive y rotation', 'negative z rotation', or 'positive z rotation'.

**WR3:** The **support\_constraint\_representation** shall contain exactly one **ratio\_measure\_with\_unit**.

**WR4:** The **support\_constraint\_representation** shall contain exactly one **descriptive\_representation\_item**.

### 5.2.3.1.108 swage\_fitting\_class

A **swage\_fitting\_class** is a type of **group** that classifies the items that are assigned to it as swage fittings.

#### EXPRESS specification:

```

*)
ENTITY swage_fitting_class
  SUBTYPE OF (group);
WHERE
  WR1: SIZEOF (QUERY (aca <* QUERY (ca <* USEDIN (SELF,
    'PLANT_SPATIAL_CONFIGURATION.CLASSIFICATION_ASSIGNMENT.' +
    'ASSIGNED_CLASS') |
    'PLANT_SPATIAL_CONFIGURATION.APPLIED_CLASSIFICATION_ASSIGNMENT' IN
    TYPEOF (ca)) |
    NOT (SIZEOF (QUERY (it <* aca.items |
    NOT ('PLANT_SPATIAL_CONFIGURATION.PIPING_COMPONENT_DEFINITION' IN
    TYPEOF (it)))) = 0))) = 0;
  WR2: SIZEOF (QUERY (aca <* QUERY (ca <* USEDIN (SELF,
    'PLANT_SPATIAL_CONFIGURATION.CLASSIFICATION_ASSIGNMENT.' +
    'ASSIGNED_CLASS') |
    'PLANT_SPATIAL_CONFIGURATION.APPLIED_CLASSIFICATION_ASSIGNMENT' IN
    TYPEOF (ca)) |
    NOT (SIZEOF (QUERY (pcd <* QUERY (it <* aca.items |
    'PLANT_SPATIAL_CONFIGURATION.PIPING_COMPONENT_DEFINITION' IN
    TYPEOF (it)) |
    NOT (SIZEOF (QUERY (aca1 <* USEDIN (pcd.formation.of_product,
    'PLANT_SPATIAL_CONFIGURATION.' +
    'APPLIED_CLASSIFICATION_ASSIGNMENT.ITEMS') |
    class_in_tree (aca.assigned_class, 'swage'))
    = 1))) = 0))) = 0;
END_ENTITY;
(*

```

#### Formal propositions:

**WR1:** A **swage\_fitting\_class** shall classify items of type **pipng\_component\_definition**.

**WR2:** A **swage\_fitting\_class** shall classify items of type **pipng\_component\_definition** that are a definition of a **product** that is categorized as a 'swage'.

### 5.2.3.1.109 system\_class

A **system\_class** is a type of **group** that classifies items that are assigned to it as systems. The name of the **system\_class** may further classify the assigned item.

#### EXPRESS specification:

```
*)
ENTITY system_class
  SUBTYPE OF (group);
WHERE
  WR1: SIZEOF (QUERY (aca <* QUERY (ca <* USEDIN (SELF,
    'PLANT_SPATIAL_CONFIGURATION.CLASSIFICATION_ASSIGNMENT.' +
    'ASSIGNED_CLASS') |
    'PLANT_SPATIAL_CONFIGURATION.APPLIED_CLASSIFICATION_ASSIGNMENT' IN
    TYPEOF (ca)) |
    NOT (SIZEOF (QUERY (it <* aca.items |
    NOT (SIZEOF (TYPEOF (it) *
    [ 'PLANT_SPATIAL_CONFIGURATION.CABLEWAY_SYSTEM',
    'PLANT_SPATIAL_CONFIGURATION.DUCTING_SYSTEM',
    'PLANT_SPATIAL_CONFIGURATION.ELECTRICAL_SYSTEM',
    'PLANT_SPATIAL_CONFIGURATION.INSTRUMENTATION_AND_CONTROL_SYSTEM',
    'PLANT_SPATIAL_CONFIGURATION.PIPING_SYSTEM',
    'PLANT_SPATIAL_CONFIGURATION.STRUCTURAL_SYSTEM'] ) = 1)
    )) = 0))) = 0;
END_ENTITY;
(*
```

#### Formal propositions:

**WR1:** A **system\_class** shall classify items of type **cableway\_system**, **ducting\_system**, **electrical\_system**, **instrumentation\_and\_control\_system**, **pipng\_system**, and **structural\_system**.

### 5.2.3.1.110 system\_space

A **system\_space** is a type of **product\_definition\_shape** that identifies the shape of the space allocated for an **electrical\_system**, **ducting\_system**, **instrumentation\_and\_control\_system**, **pipng\_system**, or **structural\_system**.

#### EXPRESS specification:

```
*)
ENTITY system_space
  SUBTYPE OF (product_definition_shape);
WHERE
  WR1: SIZEOF (TYPEOF (SELF.definition) *
    [ 'PLANT_SPATIAL_CONFIGURATION.ELECTRICAL_SYSTEM',
    'PLANT_SPATIAL_CONFIGURATION.DUCTING_SYSTEM',
    'PLANT_SPATIAL_CONFIGURATION.' +
    'INSTRUMENTATION_AND_CONTROL_SYSTEM',
    'PLANT_SPATIAL_CONFIGURATION.PIPING_SYSTEM',
    'PLANT_SPATIAL_CONFIGURATION.STRUCTURAL_SYSTEM'] ) = 1;
END_ENTITY;
(*
```

#### Formal propositions:

**WR1:** A **system\_space** shall define the shape of the space allocation for an **electrical\_system**, **ducting\_system**, **instrumentation\_and\_control\_system**, **pipng\_system**, or **structural\_system**.

system, instrumentation\_and\_control\_system, piping\_system, or structural\_system.

### 5.2.3.1.111 valve\_class

A **valve\_class** is a type of **group** that classifies the items are assigned to it as valves. The name of the **valve\_class** may further classify the assigned items.

EXPRESS specification:

```
*)
ENTITY valve_class
  SUBTYPE OF (group);
WHERE
  WR1: SIZEOF (QUERY (aca <* QUERY (ca <* USEDIN (SELF,
    'PLANT_SPATIAL_CONFIGURATION.CLASSIFICATION_ASSIGNMENT.' +
    'ASSIGNED_CLASS') |
    'PLANT_SPATIAL_CONFIGURATION.APPLIED_CLASSIFICATION_ASSIGNMENT' IN
    TYPEOF (ca)) |
    NOT (SIZEOF (QUERY (it <* aca.items |
    NOT ('PLANT_SPATIAL_CONFIGURATION.PIPING_COMPONENT_DEFINITION' IN
    TYPEOF (it)))) = 0))) = 0;
  WR2: SIZEOF (QUERY (aca <* QUERY (ca <* USEDIN (SELF,
    'PLANT_SPATIAL_CONFIGURATION.CLASSIFICATION_ASSIGNMENT.' +
    'ASSIGNED_CLASS') |
    'PLANT_SPATIAL_CONFIGURATION.APPLIED_CLASSIFICATION_ASSIGNMENT' IN
    TYPEOF (ca)) |
    NOT (SIZEOF (QUERY (pcd <* QUERY (it <* aca.items |
    'PLANT_SPATIAL_CONFIGURATION.PIPING_COMPONENT_DEFINITION' IN
    TYPEOF (it)) |
    NOT (SIZEOF (QUERY (acal <* USEDIN (pcd.formation.of_product,
    'PLANT_SPATIAL_CONFIGURATION.' +
    'APPLIED_CLASSIFICATION_ASSIGNMENT.ITEMS') |
    class_in_tree (acal.assigned_class, 'valve'))
    = 1))) = 0))) = 0;
END_ENTITY;
(*
```

Formal propositions:

**WR1:** A **valve\_class** shall classify items of type **piping\_component\_definition**.

**WR2:** A **valve\_class** shall classify items of type **piping\_component\_definition** that are a definition of a **product** that is categorized as a 'valve'.

## 5.2.3.2 Plant spatial configuration imported entity modifications

### 5.2.3.2.1 action\_request\_status

The base definition of the **action\_request\_status** entity is given in ISO 10303-41. The following modifications apply to this part of ISO 10303.

Associated global rule:

The following global rule defined in this part of ISO 10303 applies to the **action\_request\_status** entity:

- **change\_life\_cycle\_stage\_usage\_requires\_stage** (see 5.2.4.8).

### 5.2.3.2.2 application\_context

The base definition of the **application\_context** entity is given in ISO 10303-41. The following modifications apply to this part of ISO 10303.

Associated global rules:

The following global rules defined in this part of ISO 10303 apply to the **application\_context** entity:

- **application\_context\_requires\_ap\_definition** (see 5.2.4.1);
- **dependent\_instantiable\_application\_context** (see 5.2.4.9).

### 5.2.3.2.3 application\_protocol\_definition

The base definition of the **application\_protocol\_definition** entity is given in ISO 10303-41. The following modifications apply to this part of ISO 10303.

Associated global rule:

The following global rule defined in this part of ISO 10303 applies to the **application\_protocol\_definition** entity:

- **application\_context\_requires\_ap\_definition** (see 5.2.4.1).

### 5.2.3.2.4 approval

The base definition of the **approval** entity is given in ISO 10303-41. The following modifications apply to this part of ISO 10303.

Associated global rules:

The following global rules defined in this part of ISO 10303 apply to the **approval** entity:

- **approval\_requires\_approval\_date\_time** (see 5.2.4.2);
- **approval\_requires\_approval\_person\_organization** (see 5.2.4.3).

### 5.2.3.2.5 approval\_date\_time

The base definition of the **approval\_date\_time** entity is given in ISO 10303-41. The following modifications apply to this part of ISO 10303.

Associated global rule:

The following global rule defined in this part of ISO 10303 applies to the **approval\_date\_time** entity:

- **approval\_requires\_approval\_date\_time** (see 5.2.4.2).

### 5.2.3.2.6 approval\_person\_organization

The base definition of the **approval\_person\_organization** entity is given in ISO 10303-41. The

following modifications apply to this part of ISO 10303.

Associated global rule:

The following global rule defined in this part of ISO 10303 applies to the **approval\_person - organization** entity:

- **approval\_requires\_approval\_person\_organization** (see 5.2.4.3).

### 5.2.3.2.7 **description\_attribute**

The base definition of the **description\_attribute** entity is given in ISO 10303-41. The following modifications apply to this part of ISO 10303.

Associated global rule:

The following global rule defined in this part of ISO 10303 applies to the **description\_attribute** entity:

- **version2\_p41\_uninstantiable\_basic\_attributes** (see 5.2.4.21).

### 5.2.3.2.8 **externally\_defined\_item**

The base definition of the **externally\_defined\_item** entity is given in ISO 10303-41. The following modifications apply to this part of ISO 10303.

Associated global rule:

The following global rule defined in this part of ISO 10303 applies to the **externally\_defined\_item** entity:

- **subtype\_mandatory\_externally\_defined\_item** (see 5.2.4.16).

### 5.2.3.2.9 **id\_attribute**

The base definition of the **description\_attribute** entity is given in ISO 10303-41. The following modifications apply to this part of ISO 10303.

Associated global rule:

The following global rule defined in this part of ISO 10303 applies to the **id\_attribute** entity:

- **version2\_p41\_uninstantiable\_basic\_attributes** (see 5.2.4.21).

### 5.2.3.2.10 **name\_attribute**

The base definition of the **name\_attribute** entity is given in ISO 10303-41. The following modifications apply to this part of ISO 10303.

Associated global rule:

The following global rule defined in this part of ISO 10303 applies to the **description\_attribute** entity:

- **version2\_p41\_uninstantiable\_basic\_attributes** (see 5.2.4.21).

### 5.2.3.2.11 **pre\_defined\_item**

The base definition of the **pre\_defined\_item** entity is given in ISO 10303-41. The following modifications apply to this part of ISO 10303.

Associated global rule:

The following global rule defined in this part of ISO 10303 applies to the **pre\_defined\_item** entity:

- **subtype\_mandatory\_defined\_item** (see 5.2.4.17).

### 5.2.3.2.12 **product\_context**

The base definition of the **product\_context** entity is given in ISO 10303-41. The following modifications apply to this part of ISO 10303.

Associated global rules:

The following global rules defined in this part of ISO 10303 apply to the **product\_context** entity:

- **dependent\_instantiable\_product\_context** (see 5.2.4.10);
- **product\_context\_discipline\_type\_constraint** (see 5.2.4.12).

### 5.2.3.2.13 **product\_definition**

The base definition of the **product\_definition** entity is given in ISO 10303-41. The following modifications apply to this part of ISO 10303.

Associated global rule:

The following global rule defined in this part of ISO 10303 applies to the **product\_definition** entity:

- **product\_definition\_usage\_constraint** (see 5.2.4.14).

### 5.2.3.2.14 **product\_definition\_context**

The base definition of the **product\_definition\_context** entity is given in ISO 10303-41. The following modifications apply to this part of ISO 10303.

Associated global rules:

The following global rules defined in this part of ISO 10303 apply to the **product\_definition\_context** entity:

- **dependent\_instantiable\_product\_definition\_context** (see 5.2.4.11);
- **product\_definition\_context\_name\_constraint** (see 5.2.4.13).

### 5.2.3.2.15 **role\_association**

The base definition of the **role\_association** entity is given in ISO 10303-41. The following modifications apply to this part of ISO 10303.

Associated global rule:

The following global rule defined in this part of ISO 10303 applies to the **role\_association** entity:

- version2\_p41\_object\_role\_selection (see 5.2.4.20).

### 5.2.3.2.16 **versioned\_action\_request**

The base definition of the **versioned\_action\_request** entity is given in ISO 10303-41. The following modifications apply to this part of ISO 10303.

Associated global rules:

The following global rules defined in this part of ISO 10303 apply to the **versioned\_action\_request** entity:

- change\_life\_cycle\_stage\_usage\_requires\_approval (see 5.2.4.7);
- change\_life\_cycle\_stage\_usage\_requires\_stage (see 5.2.4.8);

## 5.2.4 Plant spatial configuration rule definitions

### 5.2.4.1 **application\_context\_requires\_ap\_definition**

The **application\_context\_requires\_ap\_definition** rule specifies that each instance of **application\_context** shall be referenced by exactly one **application\_protocol\_definition** that specifies this part of ISO 10303.

EXPRESS specification:

```
*)
RULE application_context_requires_ap_definition FOR
  (application_context, application_protocol_definition);
WHERE
  WR1: SIZEOF (QUERY (ac <* application_context |
    NOT (SIZEOF (QUERY (apd <* application_protocol_definition |
      (ac ::= apd.application)
      AND
      (apd.application_interpreted_model_schema_name =
        'plant_spatial_configuration')) = 1 ))) = 0;
END_RULE;
( *
```

Argument definitions:

**application\_context**: the set of all instances of the **application\_context** entity data type.

**application\_protocol\_definition**: the set of all instances of the **application\_protocol\_definition** entity data type.

Formal propositions:

**WR1:** For each instance of **application\_context**, there shall be exactly one instance of **application\_protocol\_definition** that references the instance of **application\_context** as its **application** with a value of 'plant\_spatial\_configuration' as its **application\_interpreted\_model\_schema\_name**.

#### 5.2.4.2 approval\_requires\_approval\_date\_time

Every **approval** shall have exactly one **approval\_date\_time**.

EXPRESS specification:

```
*)
RULE approval_requires_approval_date_time FOR
  (approval_date_time,
   approval);
WHERE
  WR1: SIZEOF (QUERY (app <* approval |
    NOT (SIZEOF (QUERY (adt <* approval_date_time |
      (app ::= adt.dated_approval))) = 1))) = 0;
END_RULE;
( *
```

Formal propositions:

**WR1:** For each **approval** there shall be exactly one **approval\_date\_time** that has the **approval** as its **dated\_approval**.

#### 5.2.4.3 approval\_requires\_approval\_person\_organization

Every **approval** shall have exactly one **approval\_person\_organization**.

EXPRESS specification:

```
*)
RULE approval_requires_approval_person_organization FOR
  (approval_person_organization,
   approval);
WHERE
  WR1: SIZEOF (QUERY (app <* approval |
    NOT (SIZEOF (QUERY (apo <* approval_person_organization |
      (app ::= apo.authorized_approval))) = 1))) = 0;
END_RULE;
( *
```

Formal propositions:

**WR1:** For each **approval** there shall be exactly one **approval\_person\_organization** that has the **approval** as its **authorized\_approval**.

#### 5.2.4.4 change\_action\_requires\_date

Every **change\_action** shall have a date assigned to it.

EXPRESS specification:

```
*)
RULE change_action_requires_date FOR
  (change_action,
```

```

    applied_date_assignment);
WHERE
    WR1: SIZEOF (QUERY (ca <* change_action |
        NOT (SIZEOF (QUERY (pscda <*
            applied_date_assignment |
            (ca IN pscda.items))) = 1))) = 0;
END_RULE;
(*

```

Formal propositions:

**WR1:** For each **change\_action** there shall be exactly one **applied\_date\_assignment** that contains the **change\_action** in its set of **items**.

### 5.2.4.5 change\_item\_requires\_creation\_date

Every item of a **plant\_spatial\_configuration\_change\_assignment** shall have a date assigned to it with the role of 'creation date'.

EXPRESS specification:

```

*)
RULE change_item_requires_creation_date FOR
    (plant_spatial_configuration_change_assignment,
    applied_date_assignment);
WHERE
    WR1: SIZEOF (QUERY (pscca <*
        plant_spatial_configuration_change_assignment |
        NOT (SIZEOF (QUERY (ch_it <* pscca.items |
        NOT (SIZEOF (QUERY (pscda <*
            applied_date_assignment |
            (NOT (ch_it IN pscda.items) OR
            (pscda.role.name = 'creation date')))) = 1))) = 0))) = 0;
END_RULE;
(*

```

Formal propositions:

**WR1:** For each item of a **plant\_spatial\_configuration\_change\_assignment** there shall be exactly one **applied\_date\_assignment** with a role of 'creation date' that assigns a date to the item.

### 5.2.4.6 change\_item\_requires\_id

Every item of a **plant\_spatial\_configuration\_change\_assignment** shall have an identification assigned to it.

EXPRESS specification:

```

*)
RULE change_item_requires_id FOR
    (plant_spatial_configuration_change_assignment,
    change_item_id_assignment);
WHERE
    WR1: SIZEOF (QUERY (pscca <*
        plant_spatial_configuration_change_assignment |
        NOT (SIZEOF (QUERY (ch_it <* pscca.items |
        NOT (SIZEOF (QUERY (ciia <* change_item_id_assignment |
            (ch_it IN ciia.items))) = 1))) = 0))) = 0;
END_RULE;
(*

```

Formal propositions:

**WR1:** For each item of a **plant\_spatial\_configuration\_change\_assignment** there shall be exactly one **change\_item\_id\_assignment** that assigns an identification to the item.

#### 5.2.4.7 change\_life\_cycle\_stage\_usage\_requires\_approval

Every **versioned\_action\_request** shall have an approval assigned to it.

EXPRESS specification:

```

*)
RULE change_life_cycle_stage_usage_requires_approval FOR
  (versioned_action_request,
   applied_approval_assignment);
WHERE
  WR1: SIZEOF (QUERY (vareq <* versioned_action_request |
    NOT (SIZEOF (QUERY (pscaa <*
      applied_approval_assignment |
        vareq IN pscaa.items)) = 1))) = 0;
END_RULE;
( *
```

Formal propositions:

**WR1:** For each **versioned\_action\_request** there shall be exactly one **applied\_approval\_assignment** that contains the **versioned\_action\_request** in its set of items.

#### 5.2.4.8 change\_life\_cycle\_stage\_usage\_requires\_stage

Every **versioned\_action\_request** shall have a status assigned to it.

EXPRESS specification:

```

*)
RULE change_life_cycle_stage_usage_requires_stage FOR
  (versioned_action_request,
   action_request_status);
WHERE
  WR1: SIZEOF (QUERY (vareq <* versioned_action_request |
    NOT (SIZEOF (QUERY (ars <* action_request_status |
      vareq ::= ars.assigned_request)) = 1))) = 0;
END_RULE;
( *
```

Formal propositions:

**WR1:** For each **versioned\_action\_request** there shall be exactly one **action\_request\_status** that has the **versioned\_action\_request** as its **assigned\_request**.

#### 5.2.4.9 dependent\_instantiable\_application\_context

The **dependent\_instantiable\_application\_context** rule specifies that all instances of **application\_context** are dependent on their usage to define another entity.

EXPRESS specification:

```

*)
RULE dependent_instantiable_application_context FOR (application_context);
```

```

WHERE
  WR1: SIZEOF (QUERY (ac <* application_context |
    NOT (SIZEOF (USEDIN (ac, '')) >= 1))) = 0;
END_RULE;
( *

```

Argument definition:

**application\_context**: the set of all instances of the **application\_context** entity data type.

Formal proposition:

**WR1**: For each instance of **application\_context**, there shall be a reference to the **application\_context** instance from an attribute of another entity.

### 5.2.4.10 dependent\_instantiable\_product\_context

The **dependent\_instantiable\_product\_context** rule specifies that all instances of **product\_context** are dependent on their usage to define another entity.

EXPRESS specification:

```

*)
RULE dependent_instantiable_product_context FOR (product_context);
WHERE
  WR1: SIZEOF (QUERY (pc <* product_context |
    NOT (SIZEOF (USEDIN (pc, '')) >= 1))) = 0;
END_RULE;
( *

```

Argument definition:

**product\_context**: the set of all instances of the **product\_context** entity data type.

Formal proposition:

**WR1**: For each instance of **product\_context**, there shall be a reference to the **product\_context** instance from an attribute of another entity.

### 5.2.4.11 dependent\_instantiable\_product\_definition\_context

The **dependent\_instantiable\_product\_definition\_context** rule specifies that all instances of **product\_definition\_context** are dependent on their usage to define another entity.

EXPRESS specification:

```

*)
RULE dependent_instantiable_product_definition_context FOR
  (product_definition_context);
WHERE
  WR1: SIZEOF (QUERY (pdc <* product_definition_context |
    NOT (SIZEOF (USEDIN (pdc, '')) >= 1))) = 0;
END_RULE;
( *

```

Argument definition:

**product\_definition\_context**: the set of all instances of the **product\_definition\_context** entity data type.

Formal proposition:

**WR1**: For each instance of **product\_definition\_context**, there shall be a reference to the **product\_definition\_context** instance from an attribute of another entity.

#### 5.2.4.12 product\_context\_discipline\_type\_constraint

Every **product\_context** shall have a **discipline\_type** of 'process plant'.

EXPRESS specification:

```
*)
RULE product_context_discipline_type_constraint FOR
  (product_context);
WHERE
  WR1: SIZEOF (QUERY (pc <* product_context |
    NOT (pc.discipline_type = 'process plant')))) = 0;
END_RULE;
( *
```

Formal propositions:

**WR1**: For each **product\_context**, the **name** shall be 'process plant'.

#### 5.2.4.13 product\_definition\_context\_name\_constraint

Every **product\_definition\_context** shall have a name of 'functional definition', 'physical definition', 'functional occurrence', 'physical occurrence', 'catalogue definition', or 'fabrication assembly'.

EXPRESS specification:

```
*)
RULE product_definition_context_name_constraint FOR
  (product_definition_context);
WHERE
  WR1: SIZEOF (QUERY (pdc <* product_definition_context |
    NOT (pdc.name IN
      ['functional definition', 'physical definition',
       'functional occurrence', 'physical occurrence',
       'catalogue definition', 'fabrication assembly']))) = 0;
END_RULE;
( *
```

Formal propositions:

**WR1**: For each **product\_definition\_context**, the **name** shall be 'functional definition', 'physical definition', 'functional occurrence', 'physical occurrence', 'catalogue definition', or 'fabrication assembly'.

#### 5.2.4.14 product\_definition\_usage\_constraint

Every **product\_definition** that identifies an item that may be used as a component of a plant shall have restricted participation in relationships with other **product\_definitions**.

EXPRESS specification:

```

*)
RULE product_definition_usage_constraint FOR (product_definition);
WHERE
  WR1: SIZEOF (QUERY (pd <* product_definition |
    ((pd.frame_of_reference.name = 'physical occurrence') AND
    (NOT (SIZEOF (QUERY (pdr <* USEDIN (pd,
    'PLANT_SPATIAL_CONFIGURATION.PRODUCT_DEFINITION_RELATIONSHIP.' +
    'RELATED_PRODUCT_DEFINITION') |
    SIZEOF (TYPEOF (pdr) *
    [ 'PLANT_SPATIAL_CONFIGURATION.PRODUCT_DEFINITION_USAGE',
    'PLANT_SPATIAL_CONFIGURATION.MAKE_FROM_USAGE_OPTION',
    'PLANT_SPATIAL_CONFIGURATION.ASSEMBLY_COMPONENT_USAGE' ] )
    = 1)) <= 1)))))) = 0;
END_RULE;
( *

```

Formal propositions:

**WR1:** For each **product\_definition** that has a **product\_definition\_context** where the name is 'physical occurrence', the **product\_definition** shall be the **related product\_definition** in at most one **product\_definition\_usage**, **make\_from\_usage\_option**, or **assembly\_component\_usage**.

### 5.2.4.15 subtype\_exclusive\_characterized\_object

All instances of **characterized\_object** shall be an instance of at most one of **pipng\_component\_class**, **site**, **stream\_design\_case**, or **inspection\_condition**.

EXPRESS specification:

```

*)
RULE subtype_exclusive_characterized_object FOR
  (characterized_object);
WHERE
  WR1: SIZEOF (QUERY (co <*characterized_object |
    NOT (SIZEOF ([ 'PLANT_SPATIAL_CONFIGURATION.PIPING_COMPONENT_CLASS',
    'PLANT_SPATIAL_CONFIGURATION.SITE',
    'PLANT_SPATIAL_CONFIGURATION.STREAM_DESIGN_CASE' ]
    * TYPEOF (co)) <= 1))) = 0;
END_RULE;
( *

```

Formal propositions:

**WR1:** Every instance of **characterized\_object** shall also be an instance of at most one of **pipng\_component\_class**, **site**, or **stream\_design\_case**.

### 5.2.4.16 subtype\_mandatory\_externally\_defined\_item

All instances of **externally\_defined\_item** shall either be instances of **known\_source** or of **externally\_defined\_document**.

EXPRESS specification:

```

*)
RULE subtype_mandatory_externally_defined_item FOR
  (externally_defined_item);
WHERE
  WR1: SIZEOF (QUERY (edi <* externally_defined_item |
    NOT (SIZEOF ([ 'PLANT_SPATIAL_CONFIGURATION.CATALOGUE_CONNECTOR',

```

```

        'PLANT_SPATIAL_CONFIGURATION.EXTERNALLY_DEFINED_CLASS',
        'PLANT_SPATIAL_CONFIGURATION.EXTERNALLY_DEFINED_PLANT_ITEM_DEFINITION',
        'PLANT_SPATIAL_CONFIGURATION.EXTERNALLY_DEFINED_DOCUMENT']
        * TYPEOF (edi)) = 1))) = 0;
END_RULE;
( *

```

#### Formal propositions:

**WR1:** Every instance of **externally\_defined\_item** shall also be an instance of one of **catalogue\_connector**, **externally\_defined\_classification**, **externally\_defined\_plant\_item\_definition**, or **externally\_defined\_document**.

### 5.2.4.17 subtype\_mandatory\_pre\_defined\_item

All instances of **pre\_defined\_item** shall be instances of **known\_source**.

#### EXPRESS specification:

```

*)
RULE subtype_mandatory_pre_defined_item FOR
  (pre_defined_item);
WHERE
  WR1: SIZEOF (QUERY (pdi <* pre_defined_item |
    NOT ('PLANT_SPATIAL_CONFIGURATION.KNOWN_SOURCE' IN
      TYPEOF (pdi)))) = 0;
END_RULE;
( *

```

#### Formal propositions:

**WR1:** Every instance of **pre\_defined\_item** shall also be an instance of **known\_source**.

### 5.2.4.18 subtype\_mandatory\_shape\_representation

All instances of **shape\_representation** shall be instances of exactly one of **hybrid\_shape\_representation**, **plant\_csg\_shape\_representation**, **shape\_dimension\_representation**, **site\_representation**, or **plant\_design\_csg\_primitive**.

#### EXPRESS specification:

```

*)
RULE subtype_mandatory_shape_representation FOR
  (shape_representation);
WHERE
  WR1: SIZEOF (QUERY (sr <* shape_representation |
    NOT (SIZEOF ([ 'PLANT_SPATIAL_CONFIGURATION.' +
      'PLANT_CSG_SHAPE_REPRESENTATION',
      'PLANT_SPATIAL_CONFIGURATION.HYBRID_SHAPE_REPRESENTATION',
      'PLANT_SPATIAL_CONFIGURATION.SHAPE_DIMENSION_REPRESENTATION',
      'PLANT_SPATIAL_CONFIGURATION.' +
      'SITE_REPRESENTATION',
      'PLANT_SPATIAL_CONFIGURATION.PLANT_DESIGN_CSG_PRIMITIVE' ]
    * TYPEOF (sr)) = 1))) = 0;
END_RULE;
( *

```

#### Formal propositions:

**WR1:** Every instance of **shape\_representation** shall be an instance of exactly one of **plant\_csg\_shape\_representation**, **hybrid\_shape\_representation**, **shape\_dimension\_representation**, **site\_representation**, or **plant\_design\_csg\_primitive**.

**representation**, **hybrid\_shape\_representation**, **shape\_dimension\_representation**, **site\_representation**, or **plant\_design\_csg\_primitive**.

#### 5.2.4.19 value\_for\_application\_context

The application attribute of **application\_context** shall have a value of 'plant spatial configuration'.

EXPRESS specification:

```
*)
RULE value_for_application_context FOR
  (application_context);
WHERE
  WR1: SIZEOF (QUERY (ac <* application_context |
    NOT (ac.application = 'plant spatial configuration')))) = 0;
END_RULE;
( *
```

Formal propositions:

**WR1:** Every **application\_context** shall have an application attribute with a value of 'plant spatial configuration'.

#### 5.2.4.20 version2\_p41\_object\_role\_selection

Every **role\_association** instance shall associate a role with only a **plant\_spatial\_configuration\_change\_assignment**.

EXPRESS specification:

```
*)
RULE version2_p41_object_role_selection FOR
  (role_association);
WHERE
  WR1: SIZEOF (QUERY (ra <* role_association |
    NOT ('PLANT_SPATIAL_CONFIGURATION.' +
      'PLANT_SPATIAL_CONFIGURATION_CHANGE_ASSIGNMENT' IN
      TYPEOF (ra.item_with_role)))) = 0;
END_RULE;
( *
```

Formal propositions:

**WR1:** Each **role\_association** shall reference only instances of **plant\_spatial\_configuration\_change\_assignment** as its **item\_with\_role**.

#### 5.2.4.21 version2\_p41\_uninstantiable\_basic\_attributes

There shall be no instances of **description\_attribute**, **id\_attribute**, or **name\_attribute** populated according to this part of ISO 10303.

EXPRESS specification:

```
*)
RULE version2_p41_uninstantiable_basic_attributes FOR
  (description_attribute, id_attribute, name_attribute);
WHERE
  WR1: SIZEOF (bag_to_set (description_attribute)) = 0;
  WR2: SIZEOF (bag_to_set (id_attribute)) = 0;
```

```

WR3: SIZEOF (bag_to_set (name_attribute)) = 0;
END_RULE;
( *

```

### Formal propositions:

**WR1:** There shall be zero instances of **description\_attribute**.

**WR2:** There shall be zero instances of **id\_attribute**.

**WR3:** There shall be zero instances of **name\_attribute**.

## 5.2.5 Plant spatial configuration function definitions

### 5.2.5.1 applied\_identification\_correlation

The **applied\_organization\_correlation** boolean function returns TRUE if the **name** attribute of the **identification\_role** entity is coordinated with the type of entity selected in the **items** of an **applied\_organization\_assignment**.

#### EXPRESS specification:

```

*)
FUNCTION applied_identification_correlation
  (aia : applied_identification_assignment ) : BOOLEAN;
LOCAL
  i_role : STRING;
END_LOCAL;
  i_role := aia\identification_assignment.role.name;
CASE i_role OF
  'global unambiguous identifier' :
    IF SIZEOF (aia.items) <>
      SIZEOF (QUERY (x <* aia.items |
        'PLANT_SPATIAL_CONFIGURATION.PRODUCT_DEFINITION'
        IN TYPEOF (x)))
      THEN RETURN(FALSE);
    END_IF;
  'stock code' : IF SIZEOF (aia.items) <>
    SIZEOF (QUERY (x <* aia.items |
      'PLANT_SPATIAL_CONFIGURATION.PRODUCT_DEFINITION'
      IN TYPEOF (x)))
    THEN RETURN(FALSE);
    END_IF;
  'weld id' : IF SIZEOF (aia.items) <>
    SIZEOF (QUERY (x <* aia.items |
      'PLANT_SPATIAL_CONFIGURATION.MATERIAL_PROPERTY'
      IN TYPEOF (x)))
    THEN RETURN(FALSE);
    END_IF;
  'connecting portion id' : IF SIZEOF (aia.items) <>
    SIZEOF (QUERY (x <* aia.items |
      'PLANT_SPATIAL_CONFIGURATION.MATERIAL_PROPERTY'
      IN TYPEOF (x)))
    THEN RETURN(FALSE);
    END_IF;
  'analysis data point id' : IF SIZEOF (aia.items) <>
    SIZEOF (QUERY (x <* aia.items |
      'PLANT_SPATIAL_CONFIGURATION.SHAPE_ASPECT'
      IN TYPEOF (x)))
    THEN RETURN(FALSE);
    END_IF;
  'document version id'

```

```

: IF SIZEOF (aia.items) <>
  SIZEOF (QUERY (x <* aia.items |
    'PLANT_SPATIAL_CONFIGURATION.DOCUMENT'
  IN TYPEOF (x)))
  THEN RETURN(FALSE);
  END_IF;
  OTHERWISE : RETURN(TRUE);
END_CASE;
RETURN (TRUE);
END_FUNCTION;
( *
```

#### Argument definitions:

**aia**: the input **applied\_identification\_assignment** to be checked.

### 5.2.5.2 bag\_to\_set

The **bag\_to\_set** function converts BAGs into SETs.

**EXAMPLE** It can be used to convert the BAGs returned by the USEDIN function into SETs that can be properly assigned to variables that are SETs.

#### EXPRESS specification:

```

*)
FUNCTION bag_to_set (the_bag: BAG OF GENERIC:intype) :
  SET OF GENERIC:intype;
  LOCAL
    the_set : SET OF GENERIC:intype := [];
    i       : INTEGER;
  END_LOCAL;
  IF SIZEOF(the_bag) > 0 THEN
    REPEAT i := 1 TO HIINDEX(the_bag) BY 1;
      the_set := the_set + the_bag[i];
    END_REPEAT;
  END_IF;
  RETURN(the_set);
END_FUNCTION;
( *
```

#### Argument definitions:

**the\_bag**: the BAG that is to be converted into a SET.

### 5.2.5.3 class\_in\_tree

The **class\_in\_tree** function is a boolean function that returns true if the specified **group** has the **name** specified by the **val** parameter, or if the specified **group** has a parent in a tree of related **groups** with the **name** specified by the **val** parameter.

#### EXPRESS specification:

```

*)
FUNCTION class_in_tree (class : group; val : STRING) : BOOLEAN;
  IF class.name = val THEN RETURN (TRUE);
  ELSE
    RETURN (SIZEOF (QUERY (gr <* USEDIN (class,
      'PLANT_SPATIAL_CONFIGURATION.' +
      'GROUP_RELATIONSHIP.RELATED_GROUP') |
      class_in_tree (gr.relatng_group, val))) = 1);
  END_IF;
END_FUNCTION;
```

```

    RETURN (FALSE);
END_FUNCTION;
( *

```

#### Argument definitions:

**class:** the **group** containing the **name** for which the specified value is required.

**val:** the **value** that is required for the name of the **group**.

### 5.2.5.4 plant\_spatial\_configuration\_organization\_correlation

The **plant\_spatial\_configuration\_organization\_correlation** boolean function returns TRUE if the **name** attribute of the **organization\_role** entity is coordinated with the type of entity selected in the **items** of a **plant\_spatial\_configuration\_organization\_assignment**.

**EXAMPLE** If the role for an **organization** is 'vendor', then all of the **items** in the set must be either **product** or **document**.

#### EXPRESS specification:

```

*)
FUNCTION plant_spatial_configuration_organization_correlation
  (e : plant_spatial_configuration_organization_assignment) : BOOLEAN;
LOCAL
  o_role : STRING;
END_LOCAL;
  o_role := e\organization_assignment.role.name;
CASE o_role OF
  'vendor' : IF SIZEOF (e.items) <>
              SIZEOF (QUERY (x <* e.items |
              SIZEOF(['PLANT_SPATIAL_CONFIGURATION.PRODUCT',
              'PLANT_SPATIAL_CONFIGURATION.DOCUMENT'] *
              TYPEOF (x)) = 1))
              THEN RETURN(FALSE);
              END_IF;
  'owner' : IF SIZEOF (e.items) <>
              SIZEOF (QUERY (x <* e.items |
              SIZEOF(['PLANT_SPATIAL_CONFIGURATION.SITE',
              'PLANT_SPATIAL_CONFIGURATION.DOCUMENT'] *
              TYPEOF (x)) = 1))
              THEN RETURN(FALSE);
              END_IF;
  'plant operator' : IF SIZEOF (e.items) <>
                      SIZEOF (QUERY (x <* e.items |
                      'PLANT_SPATIAL_CONFIGURATION.PLANT'
                      IN TYPEOF (x)))
                      THEN RETURN(FALSE);
                      END_IF;
  'plant owner' : IF SIZEOF (e.items) <>
                   SIZEOF (QUERY (x <* e.items |
                   'PLANT_SPATIAL_CONFIGURATION.PLANT'
                   IN TYPEOF (x)))
                   THEN RETURN(FALSE);
                   END_IF;
  'project owner' : IF SIZEOF (e.items) <>
                     SIZEOF (QUERY (x <* e.items |
                     'PLANT_SPATIAL_CONFIGURATION.DESIGN_PROJECT'
                     IN TYPEOF (x)))
                     THEN RETURN(FALSE);
                     END_IF;
  'assessor' : IF SIZEOF (e.items) <>
                SIZEOF (QUERY (x <* e.items |
                'PLANT_SPATIAL_CONFIGURATION.' +
                'PRODUCT_DEFINITION_RELATIONSHIP'

```

```

                                IN TYPEOF (x)))
                                THEN RETURN(FALSE);
                                END_IF;
    OTHERWISE : RETURN(TRUE);
END_CASE;
RETURN (TRUE);
END_FUNCTION;
( *

```

Argument definitions:

e: the input **plant\_spatial\_configuration\_organization\_assignment** to be checked.

### 5.2.5.5 plant\_spatial\_configuration\_person\_and\_organization\_correlation

The **plant\_spatial\_configuration\_person\_and\_organization\_correlation** boolean function returns TRUE if the **name** attribute of the **person\_organization\_role** entity is coordinated with the type of entity selected in the **items** of a **plant\_spatial\_configuration\_person\_and\_organization\_assignment**.

EXAMPLE If the role for a **person\_and\_organization** is 'owner', then all of the **items** in the set must be either **site** or **change\_item**.

EXPRESS specification:

```

*)
FUNCTION plant_spatial_configuration_person_and_organization_correlation
(e : plant_spatial_configuration_person_and_organization_assignment )
: BOOLEAN;
LOCAL
    po_role : STRING;
END_LOCAL;
    po_role := e\person_and_organization_assignment.role.name;
CASE po_role OF
    'owner'
        : IF SIZEOF (e.items) <>
            SIZEOF (QUERY (x <* e.items |
                SIZEOF(['PLANT_SPATIAL_CONFIGURATION.SITE',
                    'PLANT_SPATIAL_CONFIGURATION.' +
                    'CHANGE_ITEM'] *
                    TYPEOF (x)) = 1))
            THEN RETURN(FALSE);
            END_IF;
    'plant owner'
        : IF SIZEOF (e.items) <>
            SIZEOF (QUERY (x <* e.items |
                'PLANT_SPATIAL_CONFIGURATION.PLANT'
                IN TYPEOF (x)))
            THEN RETURN(FALSE);
            END_IF;
    'plant operator'
        : IF SIZEOF (e.items) <>
            SIZEOF (QUERY (x <* e.items |
                'PLANT_SPATIAL_CONFIGURATION.PLANT'
                IN TYPEOF (x)))
            THEN RETURN(FALSE);
            END_IF;
    OTHERWISE : RETURN(TRUE);
END_CASE;
RETURN (TRUE);
END_FUNCTION;
( *

```

Argument definitions:

e: the input **plant\_spatial\_configuration\_person\_and\_organization\_assignment** to be checked.

### 5.2.5.6 plant\_spatial\_configuration\_person\_correlation

The **plant\_spatial\_configuration\_person\_correlation** boolean function returns TRUE if the **name** attribute of the **person\_role** entity is coordinated with the type of entity selected in the **items** of a **plant\_spatial\_configuration\_person\_assignment**.

EXAMPLE If the role for a **person** is 'owner', then all of the **items** in the set must be either **site** or **document**.

EXPRESS specification:

```

*)
FUNCTION plant_spatial_configuration_person_correlation
  (e : plant_spatial_configuration_person_assignment ) : BOOLEAN;
  LOCAL
    p_role : STRING;
  END_LOCAL;
  p_role := e\person_assignment.role.name;
  CASE p_role OF
    'vendor' : IF SIZEOF (e.items) <>
              SIZEOF (QUERY (x <* e.items |
                'PLANT_SPATIAL_CONFIGURATION.DOCUMENT'
              IN TYPEOF (x)))
              THEN RETURN(FALSE);
              END_IF;
    'owner' : IF SIZEOF (e.items) <>
              SIZEOF (QUERY (x <* e.items |
                SIZEOF(['PLANT_SPATIAL_CONFIGURATION.SITE',
                  'PLANT_SPATIAL_CONFIGURATION.DOCUMENT'] *
                TYPEOF (x)) = 1))
              THEN RETURN(FALSE);
              END_IF;
    'plant owner' : IF SIZEOF (e.items) <>
                    SIZEOF (QUERY (x <* e.items |
                      'PLANT_SPATIAL_CONFIGURATION.PLANT'
                    IN TYPEOF (x)))
                    THEN RETURN(FALSE);
                    END_IF;
    'assessor' : IF SIZEOF (e.items) <>
                  SIZEOF (QUERY (x <* e.items |
                    'PLANT_SPATIAL_CONFIGURATION.' +
                    'PRODUCT_DEFINITION_RELATIONSHIP'
                  IN TYPEOF (x)))
                  THEN RETURN(FALSE);
                  END_IF;
    OTHERWISE : RETURN(TRUE);
  END_CASE;
  RETURN (TRUE);
END_FUNCTION;
( *

```

Argument definitions:

e: the input **plant\_spatial\_configuration\_person\_assignment** to be checked.

### 5.2.5.7 valid\_advanced\_csg\_tree

The **valid\_advanced\_csg\_tree** function returns true if the elements that comprise the CSG tree passed in as a parameter satisfy the requirements defined for advanced CSG trees.

EXPRESS specification:

```

*)
FUNCTION valid_advanced_csg_tree (tree_element : boolean_operand) : BOOLEAN;
  -- return true if the tree_element is a valid primitive

```

```

IF SIZEOF (typeof (tree_element) *
['PLANT_SPATIAL_CONFIGURATION.BLOCK',
'PLANT_SPATIAL_CONFIGURATION.TORUS',
'PLANT_SPATIAL_CONFIGURATION.RIGHT_CIRCULAR_CYLINDER',
'PLANT_SPATIAL_CONFIGURATION.SPHERE',
'PLANT_SPATIAL_CONFIGURATION.RIGHT_CIRCULAR_CONE',
'PLANT_SPATIAL_CONFIGURATION.ECCENTRIC_CONE',
'PLANT_SPATIAL_CONFIGURATION.PLANT_DESIGN_CSG_PRIMITIVE',
'PLANT_SPATIAL_CONFIGURATION.CYCLIDE_SEGMENT_SOLID',
'PLANT_SPATIAL_CONFIGURATION.RECTANGULAR_PYRAMID',
'PLANT_SPATIAL_CONFIGURATION.EXTRUDED_AREA_SOLID',
'PLANT_SPATIAL_CONFIGURATION.REVOLVED_AREA_SOLID',
'PLANT_SPATIAL_CONFIGURATION.HALF_SPACE_SOLID']) = 1
THEN RETURN (TRUE);
ELSE
-- if the tree_element is a boolean_result check its operations and
-- operands
IF 'PLANT_SPATIAL_CONFIGURATION.BOOLEAN_RESULT'
IN typeof (tree_element)
THEN
-- addition and subtraction are the only valid operations
IF NOT (tree_element\boolean_result.operator
IN [boolean_operator.union, boolean_operator.difference])
THEN RETURN (FALSE);
END_IF;
-- if the operand is a half_space_solid, check for advanced surface
-- otherwise return false and recursively check second operand
IF 'PLANT_SPATIAL_CONFIGURATION.HALF_SPACE_SOLID' IN
typeof (tree_element\boolean_result.first_operand) THEN
IF 'PLANT_SPATIAL_CONFIGURATION.ELEMENTARY_SURFACE' IN
typeof (tree_element\boolean_result.
first_operand\half_space_solid.base_surface) THEN
IF 'PLANT_SPATIAL_CONFIGURATION.HALF_SPACE_SOLID' IN
typeof (tree_element\boolean_result.second_operand) THEN
IF 'PLANT_SPATIAL_CONFIGURATION.ELEMENTARY_SURFACE' IN
typeof (tree_element\boolean_result.
second_operand\half_space_solid.base_surface) THEN
RETURN (TRUE);
ELSE RETURN (FALSE);
END_IF;
ELSE RETURN (valid_advanced_csg_tree
(tree_element\boolean_result.second_operand));
END_IF;
ELSE RETURN (FALSE);
END_IF;
ELSE
IF 'PLANT_SPATIAL_CONFIGURATION.HALF_SPACE_SOLID' IN
typeof (tree_element\boolean_result.second_operand) THEN
IF 'PLANT_SPATIAL_CONFIGURATION.ELEMENTARY_SURFACE' IN typeof
(tree_element\boolean_result.second_operand\half_space_solid.
base_surface) THEN
RETURN (valid_advanced_csg_tree
(tree_element\boolean_result.first_operand));
ELSE
RETURN (FALSE);
END_IF;
ELSE
RETURN (valid_advanced_csg_tree
(tree_element\boolean_result.first_operand) AND
valid_advanced_csg_tree
(tree_element\boolean_result.second_operand));
END_IF;
END_IF;
END_IF;
RETURN (FALSE);
END_FUNCTION;
(*

```

Argument definitions:

**tree\_element**: (input) the **boolean\_operand** to be evaluated.

```
* )  
END_SCHEMA ;  
( *
```

## 6 Conformance requirements

Conformance to this part of ISO 10303 includes satisfying the requirements stated in this part, the requirements of the implementation method(s) supported, and the relevant requirements of the normative references.

An implementation shall support at least one of the following implementation methods:

— ISO 10303-21.

Requirements with respect to implementation methods-specific requirements are specified in annex C.

The Protocol Information Conformance Statement (PICS) proforma lists the options or the combinations of options that may be included in the implementation. The PICS proforma is provided in annex D.

This part of ISO 10303 provides for a number of options that may be supported by an implementation. These options have been grouped into the following conformance classes:

- class 1 - provides piping system functional information;
- class 2 - provides equipment and component spatial information;
- class 3 - provides plant layout and piping design information;
- class 4 - provides piping fabrication and installation information;
- class 5 - provides piping inspection information;
- class 6 - provides HVAC system functional information;
- class 7 - provides HVAC spatial information;
- class 8 - provides cableway spatial information;
- class 9 - provides piping and HVAC analysis information

Support for a particular conformance class requires support of all the options specified in this class. All nine conformance classes include information concerning plant item characterization, connectors, connections, and shape information.

Table 2 defines the units of functionality included within each conformance class.

Conformance to a particular class requires that all AIM elements defined as part of that class be supported. Table 3 defines the classes that each AIM element belongs to.

NOTE ISO 10303-32: describes the conformance assessment process.

### 6.1 Conformance class 1, piping system functional information

This conformance class provides piping system functional information. This conformance class contains functional information of the piping system and catalogue reference information, but no shape or spatial information. This conformance class enables the following activity:

- exchange of functional information on plant piping systems.

NOTE 1 The purpose of this conformance class is to provide an interface with ISO 10303-221<sup>2)</sup> [3] and piping functional design and schematics software.

NOTE 2 This conformance class is related to the following data flows between AAM activities:

- piping and instrumentation diagrams (preliminary) A222 to A223, A224, and A225;
- piping and instrumentation diagrams (AFD) A222 to A232 and A235;
- piping and instrumentation diagrams (design) A232 to A241;
- piping and instrumentation diagrams A241 to A242, A243, A244, A245, and O4.

## **6.2 Conformance class 2, equipment and component spatial information**

This conformance class provides equipment and component spatial information. This conformance class contains basic equipment performance characteristics, connector location and orientation information, material specifications, version information, explicit shape, and catalogue reference information. This conformance class enables the exchange of minimal vendor equipment and component information.

NOTE This conformance class is related to the following data flows between AAM activities:

- equipment list C3 to A32;
- equipment characteristics C3 to A32;
- material requirements C3 to A32;
- specifications and standards C3 to A32 and A33;
- plant items A35 to A43.

## **6.3 Conformance class 3, plant layout and piping design information**

This conformance class provides plant layout and piping design information. This conformance class contains design, layout, and spatial information for the plant, and catalogue reference information. This conformance class enables the exchange of plant layout and piping design information and supports the following activities:

- area classification;
- space analysis;

- plant arrangement (placement of space occupying elements);
- spatial design of piping systems including pipe routing and component placement and placement of pipe supports;
- operation and maintenance analysis;
- constructability reviews;
- interference checking;
- development of equipment list and line list;
- development of equipment takeoffs;
- development of material takeoffs for piping and piping components;
- connectivity and topology checks;
- material and connection compatibility checks;
- provision of spatial design information to support fabrication and construction;
- spool and weld identification;
- plant startup;
- plant commissioning;
- plant operation;
- configuration management of plant items and piping system information.

NOTE 1 Although not explicitly cited above, this conformance class also supports the activities listed for the other conformance classes, except for piping inspection information.

NOTE 2 This conformance class is related to the following data flows between AAM activities:

- corporate standards to A22 and A24;
- societal requirements to A22 and A24;
- site information (existing) I3 to A222 and A224;
- site information (existing) I1 to A242;
- process flow diagrams C2 to A222, A223, A224, and A225;
- process flow diagrams C4 to A241;
- equipment list A223 to A222, A232, A233, and A241;
- equipment list A241 to A242, A245, and A32;

- equipment list C3 to A32;
- equipment characteristics (required) C1 to A222 and A223;
- equipment characteristics (functional) A222 to A223;
- equipment characteristics (performance) A223 to A222, A232, A233, and A241;
- equipment characteristics (performance) A241 to A242, A245, and A32;
- equipment characteristics (process) C1 to A241;
- equipment characteristics C3 to A32;
- piping and instrumentation diagrams (preliminary) A222 to A223, A224, and A225;
- piping and instrumentation diagrams (AFD) A222 to A232, A234, and A235;
- piping and instrumentation diagrams (design) C2 to A241;
- system layout (preliminary) A224 to A222, A232, A234, A235, and A242;
- system design (preliminary) A222 to A224, A232, A234, A235, and A242;
- system layout and design A242 to A243, A244, A245, and A41;
- change request (design) A222, A223, A224, and A225 to A21;
- change request (design) A241, A242, and A245 to A23;
- supplier documentation I3 to A241 and A242;
- specifications and standards C9 to A241, A242, A243, and A244;
- specifications and standards C3 to A32 and A33;
- material requirements A241 to A242, A245, and A32;
- material requirements C3 to A32;
- project-specific documents A241, A242, A243 to A32, A33, A34, and A35;
- plant items A35 to A43.

#### **6.4 Conformance class 4, piping fabrication and installation information**

This conformance class provides piping fabrication and installation information. This conformance class contains system, plant item, and line identification, piping information, plant

item characteristics and shape, and catalogue reference information. This conformance class enables the exchange of piping fabrication and installation information.

NOTE This conformance class is related to the following data flows between AAM activities:

- plant items I1 to A43;
- change request A43 to A2;
- specifications and standards to A43;
- company requirements to A43;
- project-specific documents to A43;
- supplier documentation C1 to A43;
- piping materials I2 to A4233;
- piping installation documents C2 to A42331;
- piping fabrication documents C7 to A42331;
- piping materials I2 to A42331;
- standard practice C3 to A42332;
- shop fabrication details and schedule I1 to A42332.

## 6.5 Conformance class 5, piping inspection information

This conformance class provides piping inspection information in addition to the piping fabrication and installation information provided in conformance class 4. This conformance class contains system, plant item, and line identification, piping information, plant item characteristics and shape, catalogue reference information, and piping inspection information. This conformance class enables the exchange of piping inspection information in addition to piping fabrication and installation information.

NOTE This conformance class is related to the following data flows between AAM activities:

- plant items I1 to A43;
- change request A43 to A2;
- specifications and standards to A43;
- company requirements to A43;
- project-specific documents to A43;
- supplier documentation C1 to A43;

- piping materials I2 to A4233;
- piping installation documents C2 to A42331;
- piping fabrication documents C7 to A42331;
- piping materials I2 to A42331;
- standard practice C3 to A42332;
- shop fabrication details and schedule I1 to A42332;
- piping inspection documents C5 to A42333;
- inspection procedure C8 to A42333;
- construction documentation C4 to A42334.

## **6.6 Conformance class 6, HVAC system functional information**

This conformance class provides HVAC system functional information. This conformance class contains functional information of the HVAC system and catalogue reference information, but no shape or spatial information. This conformance class enables the following activity:

- exchange of functional information on heating, ventilation, and air-conditioning (HVAC) systems.

NOTE This conformance class is related to the following data flows between AAM activities:

- piping and instrumentation diagrams (preliminary) A222 to A223, A224, and A225;
- piping and instrumentation diagrams (AFD) A222 to A232 and A235;
- piping and instrumentation diagrams (design) A232 to A241;
- piping and instrumentation diagrams A241 to A242, A243, A244, A245, and O4.

## **6.7 Conformance class 7, HVAC spatial information**

This conformance class provides HVAC layout and design information. This conformance class contains design, layout, and spatial information for the HVAC systems within the plant, and catalogue reference information. This conformance class enables the exchange of HVAC layout and design information and supports the following activities:

- area classification;
- space analysis;
- plant arrangement (placement of space occupying elements);

- spatial design of HVAC systems including component placement;
- HVAC operation and maintenance analysis;
- HVAC constructability reviews;
- interference checking;
- development of HVAC equipment list and line list;
- development of HVAC equipment takeoffs;
- development of material takeoffs for HVAC and HVAC components;
- connectivity and topology checks;
- material and connection compatibility checks;
- provision of spatial design information to support HVAC fabrication and construction.

NOTE This conformance class is related to the following data flows between AAM activities:

- corporate standards to A22 and A24;
- societal requirements to A22 and A24;
- site information (existing) I3 to A222 and A224;
- site information (existing) I1 to A242;
- HVAC equipment list A223 to A222, A232, A233, and A241;
- HVAC equipment list A241 to A242, A245, and A32;
- HVAC equipment list C3 to A32;
- HVAC equipment characteristics (required) C1 to A222 and A223;
- HVAC equipment characteristics C3 to A32;
- system layout (preliminary) A224 to A222, A232, A234, A235, and A242;
- system design (preliminary) A222 to A224, A232, A234, A235, and A242;
- system layout and design A242 to A243, A244, A245, and A41;
- change request (design) A222, A223, A224, and A225 to A21;
- change request (design) A241, A242, and A245 to A23;
- supplier documentation I3 to A241 and A242;
- specifications and standards C9 to A241, A242, A243, and A244;

- specifications and standards C3 to A32 and A33;
- material requirements A241 to A242, A245, and A32;
- material requirements C3 to A32;
- project-specific documents A241, A242, A243 to A32, A33, A34, and A35;
- plant items A35 to A43.

## 6.8 Conformance class 8, cableway spatial information

This conformance class provides cableway spatial information. This conformance class contains layout and spatial information for the cableway systems within the plant. This conformance class enables the exchange of cableway layout and spatial information, but does not provide the details of the cableway contents or the operating characteristics. Details of cableway contents or operating are beyond the scope of this edition of ISO 10303-227.

NOTE This conformance class is related to the following data flows between AAM activities:

- corporate standards to A22 and A24;
- societal requirements to A22 and A24;
- site information (existing) I3 to A222 and A224;
- site information (existing) I1 to A242;
- system layout (preliminary) A224 to A222, A232, A234, A235, and A242;
- system design (preliminary) A222 to A224, A232, A234, A235, and A242;
- system layout and design A242 to A243, A244, A245, and A41;
- change request (design) A222, A223, A224, and A225 to A21;
- change request (design) A241, A242, and A245 to A23.

## 6.9 Conformance class 9, piping and HVAC analysis information

This conformance class provides piping and HVAC analysis information. It enables the exchange of sufficient information about a piping or HVAC system for the performance of stress or flow analysis on the receiving system. It does not, however, include exchange of the results of such an analysis.

NOTE This conformance class is related to the data flow in the following AAM activity:

- analyze final plant design A245.

## 6.10 Options within a conformance class

Conformance classes may be augmented to include one or more options. Each option indicates support for a specific type of shape representation or unit of functionality.

A shape representation option specifies the type of geometric and topological entities used to provide a shape representation for plant\_items. These options are mutually exclusive, e.g. only one of A, B, or C may be specified. However, for conformance classes which include shape representation, one option must be specified.

- Option A indicates the use of Brep (Boundary representation) shape representation for the plant\_item entities in the conformance class. This option is intended for use with software systems which utilize surface models and/or brep solid models.
- Option B indicates the use of simple CSG (Constructive Solid Geometry) shape representations for the plant\_item entities in the conformance class. A simple CSG shape representation is generated entirely from CSG primitive solids. The use of solids constructed by swept surfaces, extrusion, or Brep is not supported. This option is intended for use with software systems which utilize traditional CSG solid models.
- Option C indicates the use of hybrid CSG shape representations for the plant\_item entities in the conformance class. A hybrid CSG shape representation is generated from CSG primitives solids, Brep solids, or solids defined by swept surfaces, or extrusions. This option is intended for use with software systems which utilize both brep and CSG solid models.

An option for a unit of functionality option indicates support for the entities defined by that unit of functionality.

These options are not mutually exclusion. One or more of these options may be specified. Many software systems currently provide only limited support for these units of functionality. The options are intended to specify the capabilities of conforming systems while recognizing the limitations of existing systems.

- Option P indicates the entities for the plant characterization UoF are supported
- Option S indicates the entities for the site characterization UoF are supported. Site\_characterization, in particular, allows the file to be specified as applying to a "ship" rather than to a traditional "process plant"
- Option R indicates the entities for the change information UoF are supported Change information allows revision history to be optionally included in an ISO 10303-227 file for any conformance class.

The resulting conformance class with option is designated by the conformance class number and option letter(s), e.g. Conformance Class 3 Options A,P,R.

**Table 2 - Conformance classes**

Units of functionality	Conformance classes								
	1	2	3	4	5	6	7	8	9
	PSFN	EPSP	PLSP	PFB	PIN	HSFN	HSP	CSP	PHAN
Cableway_component_characterization	-	-	X	-	-	-		X	-
Connection	X	X	X	X	X	X	X	X	X
Connector	X	X	X	X	X	X	X	X	X
HVAC_component_characterization	-	-	X	-	-	X	X	-	X
HVAC_system_functional_characterization	-	-	X	-	-	X	X	-	X
Piping_inspection	-	-	-	-	X	-	-	-	-
Piping_component_characterization	X	X	X	X	X	-	-	-	X
Piping_system_functional_characterization	X	X	X	-	-	-	-	-	X
Plant_item_characterization	X	X	X	X	X	X	X	X	X
Shape	X	X	X	X	X	X	X	X	X
Shape_representation options (Note 1) (options A, or B, or C)		A,B, C	A,B, C	A,B, C	A,B, C		A,B, C	A,B, C	
Change information (option R)	R	R	R	R	R	R	R	R	R
Plant_characterization (option P)	P	P	X	P	P	P	P	P	P
Site_characterization (option S)	S	S	S	S	S	S	S	S	S

- 1 – PSFN - Piping system functional information  
 2 – EPSP - Equipment and piping spatial information  
 3 – PLSP - Plant spatial information  
 4 – PFB - Piping fabrication and installation information  
 5 – PIN - Piping inspection information  
 6 – HSFN - HVAC system functional information  
  
 7 – HSP - HVAC spatial information  
 8 – CSP - Cableway spatial information  
 9 – PHAN - Piping and HVAC analysis information

Note 1: All conformance classes include geometric entities to represent locations, connect points, and reference geometry, e.g, centrelines. These geometric entities are specified in the mapping tables

Table 2 specifies which units of functionality participate in specific conformance classes. An “X” indicates that all ARM entities in the unit of functionality are included in the conformance class. An option, “P”, “S”, or “R”, for a unit of functionality, also indicates that all the ARM entities are included. A shape representation option, “A”, “B”, “C”, indicates that specific geometry and topology entities defined in Table 3 are included in the conformance class.

Table 3 explicitly specifies which AIM entities participate in specific conformance classes. Since specific change objects apply to specific ARM entities, Table 3 also defines which change objects are required within a given conformance class.

**Table 3 - Conformance class (1 –9) elements**

<b>AIM element</b>	<b>Conformance class</b>								
	<b>1</b>	<b>2</b>	<b>3</b>	<b>4</b>	<b>5</b>	<b>6</b>	<b>7</b>	<b>8</b>	<b>9</b>
action	X	X	X	X	X	X	X	X	X
action_assignment	X	X	X	X	X	X	X	X	X
action_directive	X	X	X	X	X	X	X	X	X
action_method	R	R	R	R	R	R	R	R	R
action_method_relationship	-	-	-	-	-	-	-	-	-
action_relationship	R	R	R	R	R	R	R	R	R
action_request_assignment	X	X	X	X	X	X	X	X	X
action_request_solution	R	R	R	R	R	R	R	R	R
action_request_status	X	X	X	X	X	X	X	X	X
action_status	R	R	R	R	R	R	R	R	R
amount_of_substance_measure_with_unit	X	X	X	X	X	X	X	X	X
amount_of_substance_unit	X	X	X	X	X	X	X	X	X
angular_location	X	X	X	X	X	X	X	X	X
application_context	X	X	X	X	X	X	X	X	X
application_context_element	X	X	X	X	X	X	X	X	X
application_protocol_definition	X	X	X	X	X	X	X	X	X
applied_action_request_assignment	X	X	X	X	X	X	X	X	X
applied_approval_assignment	X	X	X	X	X	X	X	X	X
applied_classification_assignment	X	X	X	X	X	X	X	X	X
applied_date_and_time_assignment	X	X	X	X	X	X	X	X	X
applied_date_assignment	X	X	X	X	X	X	X	X	X
applied_document_reference	X	X	X	X	X	X	X	X	X
applied_identification_assignment	X	X	X	X	X	X	X	X	X
approval	P, R	P, R	P, R	P, R	P, R	P, R	P, R	P, R	P, R
approval_assignment	P, R	P, R	P, R	P, R	P, R	P, R	P, R	P, R	P, R
approval_date_time	R	R	R	R	R	R	R	R	R
approval_person_organization	R	R	R	R	R	R	R	R	R
approval_role	R	R	R	R	R	R	R	R	R
approval_status	P	P	P	P	P	P	P	P	P
assembly_component_usage	X	X	X	X	X	X	X	X	X
axis1_placement	X	X	X	X	X	X	X	X	X
axis2_placement_2d	X	X	X	X	X	X	X	X	X
axis2_placement_3d	X	X	X	X	X	X	X	X	X

**Table 3 - Conformance class (1 –9) elements cont'd.**

AIM element	Conformance class								
	1	2	3	4	5	6	7	8	9
b_spline_curve	X	X	X	X	X	X	X	X	X
b_spline_curve_with_knots	X	X	X	X	X	X	X	X	X
b_spline_surface	S	A,C,S	A,C,S	A,C,S	A,C,S	A,C,S	A,C,S	A,C,S	A,C,S
b_spline_surface_with_knots	S	A,C,S	A,C,S	A,C,S	A,C,S	A,C,S	A,C,S	A,C,S	A,C,S
bezier_curve	X	X	X	X	X	X	X	X	X
bezier_surface	S	A,C,S	A,C,S	A,C,S	A,C,S	A,C,S	A,C,S	A,C,S	A,C,S
blank_fitting_class	X	X	X	X	X	-	-	-	X
block	-	B,C	B,C	B,C	B,C	-	B,C	B,C	-
bolt_and_nut_component_class	X	X	X	X	X	X	X	X	X
bolt_and_nut_component_definition	X	X	X	X	X	X	X	X	X
bolt_and_nut_set_definition	X	X	X	X	X	X	X	X	X
boolean_result	-	B,C	B,C	B,C	B,C	-	B,C	B,C	-
boundary_curve	S	A,C,S	A,C,S	A,C,S	A,C,S	A,C,S	A,C,S	A,C,S	A,C,S
bounded_curve	X	X	X	X	X	X	X	X	X
bounded_pcurve	S	A,C,S	A,C,S	A,C,S	A,C,S	A,C,S	A,C,S	A,C,S	A,C,S
bounded_surface	S	A,C,S	A,C,S	A,C,S	A,C,S	A,C,S	A,C,S	A,C,S	A,C,S
bounded_surface_curve	S	A,C,S	A,C,S	A,C,S	A,C,S	A,C,S	A,C,S	A,C,S	A,C,S
brep_with_voids	-	A,C	A,C	A,C	A,C	A,C	A,C	A,C	A,C
cableway_component_class	-	-	X	-	-	-	-	X	-
cableway_component_definition	-	-	X	-	-	-	-	X	-
cableway_connector_class	-	-	X	-	-	-	-	X	-
cableway_system	P	P	X	P	P	P	P	X	P
calendar_date	X	X	X	X	X	X	X	X	X
cartesian_point	X	X	X	X	X	X	X	X	X
cartesian_transformation_operator	X	X	X	X	X	X	X	X	X
cartesian_transformation_operator_3d	X	X	X	X	X	X	X	X	X
catalogue	X	X	X	X	X	X	X	X	X
catalogue_connector	X	X	X	X	X	X	X	X	X
catalogue_item	X	X	X	X	X	X	X	X	X
centre_of_symmetry	X	X	X	X	X	X	X	X	X
change_action	R	R	R	R	R	R	R	R	R
change_item_id_assignment	R	R	R	R	R	R	R	R	R
change_life_cycle_stage_assignment	R	R	R	R	R	R	R	R	R
characterized_object	X	X	X	X	X	X	X	X	X
circle	X	X	X	X	X	X	X	X	X

**Table 3 - Conformance class (1 –9) elements cont'd.**

AIM element	Conformance class								
	1	2	3	4	5	6	7	8	9
clamp_component_definition	X	X	X	X	X	X	X	X	X
clamp_set_definition	X	X	X	X	X	X	X	X	X
classification_assignment	X	X	X	X	X	X	X	X	X
classification_role	X	X	X	X	X	X	X	X	X
closed_shell	S	A,C,S	A,C,S	A,C,S	A,C,S	A,C,S	A,C,S	A,C,S	A,C,S
colour	X	X	X	X	X	X	X	X	X
colour_rgb	X	X	X	X	X	X	X	X	X
colour_specification	X	X	X	X	X	X	X	X	X
composite_curve	X	X	X	X	X	X	X	X	X
composite_curve_on_surface	S	A,C,S	A,C,S	A,C,S	A,C,S	A,C,S	A,C,S	A,C,S	A,C,S
composite_curve_segment	X	X	X	X	X	X	X	X	X
conic	X	X	X	X	X	X	X	X	X
conical_surface	S	A,C,S	A,C,S	A,C,S	A,C,S	A,C,S	A,C,S	A,C,S	A,C,S
connected_face_set	S	A,C,S	A,C,S	A,C,S	A,C,S	A,C,S	A,C,S	A,C,S	A,C,S
connection_functional_class	X	X	X	X	X	X	X	X	X
connection_material_definition	X	X	X	X	X	X	X	X	X
connection_motion_class	X	X	X	X	X	X	X	X	X
connection_node	X	X	X	-	-	-	-	-	X
connector_end_type_class	X	X	X	X	X	X	X	X	X
context_dependent_unit	X	X	X	X	X	X	X	X	X
conversion_based_unit	X	X	X	X	X	X	X	X	X
coordinated_universal_time_offset	X	X	X	X	X	X	X	X	X
csg_solid	-	B,C	B,C	B,C	B,C	-	B,C	B,C	-
curve	X	X	X	X	X	X	X	X	X
curve_bounded_surface	S	A,C,S	A,C,S	A,C,S	A,C,S	A,C,S	A,C,S	A,C,S	A,C,S
curve_replica	X	X	X	X	X	X	X	X	X
cyclide_segment_solid	-	B,C	B,C	B,C	B,C	-	B,C	B,C	-
cylindrical_surface	S	A,C,S	A,C,S	A,C,S	A,C,S	A,C,S	A,C,S	A,C,S	A,C,S
data_environment	-	-	-	-	X	-	-	-	-
date	X	X	X	X	X	X	X	X	X
date_and_time	X	X	X	X	X	X	X	X	X
date_and_time_assignment	X	X	X	X	X	X	X	X	X
date_assignment	X	X	X	X	X	X	X	X	X
date_role	X	X	X	X	X	X	X	X	X
date_time_role	X	X	X	X	X	X	X	X	X
definitional_representation	X	X	X	X	X	X	X	X	X

**Table 3 - Conformance class (1 –9) elements cont'd.**

AIM element	Conformance class								
	1	2	3	4	5	6	7	8	9
degenerate_pcurve	S	A,C,S	A,C,S	A,C,S	A,C,S	A,C,S	A,C,S	A,C,S	A,C,S
degenerate_toroidal_surface	S	A,C,S	A,C,S	A,C,S	A,C,S	A,C,S	A,C,S	A,C,S	A,C,S
derived_shape_aspect	X	X	X	X	X	X	X	X	X
derived_unit	X	X	X	X	X	X	X	X	X
derived_unit_element	X	X	X	X	X	X	X	X	X
description_attribute	-	-	-	-	-	-	-	-	-
descriptive_colour	X	X	X	X	X	X	X	X	X
descriptive_representation_item	X	X	X	X	X	X	X	X	X
design_project	X	X	X	X	X	X	X	X	X
design_project_assignment	X	X	X	X	X	X	X	X	X
dimensional_characteristic_representation	X	X	X	X	X	X	X	X	X
dimensional_exponents	X	X	X	X	X	X	X	X	X
dimensional_location	X	X	X	X	X	X	X	X	X
dimensional_size	X	X	X	X	X	X	X	X	X
directed_action	X	X	X	X	X	X	X	X	X
direction	X	X	X	X	X	X	X	X	X
document	X	X	X	X	X	X	X	X	X
document_reference	X	X	X	X	X	X	X	X	X
document_relationship	X	X	X	X	X	X	X	X	X
document_representation_type	-	-	-	-	-	-	-	-	-
document_type	X	X	X	X	X	X	X	X	X
document_usage_constraint	X	X	X	X	X	X	X	X	X
ducting_system	P	P	P	P	P	P	P	P	P
eccentric_cone	-	B,C	B,C	B,C	B,C	-	B,C	B,C	-
edge	S	A,C,S	A,C,S	A,C,S	A,C,S	A,C,S	A,C,S	A,C,S	A,C,S
edge_curve	S	A,C,S	A,C,S	A,C,S	A,C,S	A,C,S	A,C,S	A,C,S	A,C,S
edge_loop	S	A,C,S	A,C,S	A,C,S	A,C,S	A,C,S	A,C,S	A,C,S	A,C,S
elbow_fitting_class	X	X	X	X	X	-	-	-	X
electric_current_measure_with_unit	X	X	X	X	X	X	X	X	X
electric_current_unit	X	X	X	X	X	X	X	X	X
electrical_connector_class	X	X	X	X	X	X	X	X	X
electrical_system	P	P	P	P	P	P	P	P	P
elementary_surface	S	A,C,S	A,C,S	A,C,S	A,C,S	A,C,S	A,C,S	A,C,S	A,C,S
ellipse	X	X	X	X	X	X	X	X	X
ellipsoid	-	B,C	B,C	B,C	B,C	-	B,C	B,C	-
evaluated_degenerate_pcurve	S	A,C,S	A,C,S	A,C,S	A,C,S	A,C,S	A,C,S	A,C,S	A,C,S
executed_action	X	X	X	X	X	X	X	X	X
external_source	X	X	X	X	X	X	X	X	X
externally_defined_class	X	X	X	X	X	X	X	X	X
externally_defined_document	P	P	P	P	P	P	P	P	P

**Table 3 - Conformance class (1 –9) elements cont'd.**

AIM element	Conformance class								
	1	2	3	4	5	6	7	8	9
externally_defined_item	X	X	X	X	X	X	X	X	X
externally_defined_item_relationship	-	-	-	-	-	-	-	-	-
externally_defined_plant_item_definition	X	X	X	X	X	X	X	X	X
externally_defined_representation_item	X	X	X	X	X	X	X	X	X
extruded_area_solid	-	A,C	A,C	A,C	A,C	A,C	A,C	A,C	A,C
extruded_face_solid	-	A,C	A,C	A,C	A,C	A,C	A,C	A,C	A,C
face	S	A,C,S	A,C,S	A,C,S	A,C,S	A,C,S	A,C,S	A,C,S	A,C,S
face_bound	S	A,C,S	A,C,S	A,C,S	A,C,S	A,C,S	A,C,S	A,C,S	A,C,S
face_outer_bound	S	A,C,S	A,C,S	A,C,S	A,C,S	A,C,S	A,C,S	A,C,S	A,C,S
face_surface	S	A,C,S	A,C,S	A,C,S	A,C,S	A,C,S	A,C,S	A,C,S	A,C,S
faceted_brep	-	A,C	A,C	A,C	A,C	A,C	A,C	A,C	A,C
flange_fitting_class	X	X	X	X	X	-	-	-	X
flange_fitting_neck_type_class	X	X	X	X	X	-	-	-	X
founded_item	X	X	X	X	X	X	X	X	X
functionally_defined_transformation	X	X	X	X	X	X	X	X	X
geometric_curve_set	X	X	X	X	X	X	X	X	X
geometric_representation_context	X	X	X	X	X	X	X	X	X
geometric_representation_item	X	X	X	X	X	X	X	X	X
geometric_set	X	X	X	X	X	X	X	X	X
geometric_set_replica	X	X	X	X	X	X	X	X	X
global_unit_assigned_context	X	X	X	X	X	X	X	X	X
group	X	X	X	X	X	X	X	X	X
group_assignment	X	X	X	X	X	X	X	X	X
group_relationship	X	X	X	X	X	X	X	X	X
half_space_solid	-	B,C	B,C	B,C	B,C	-	B,C	B,C	-
heat_tracing_representation	X	X	X	X	X	X	X	X	X
hvac_branch_connection	-	-	X	-	-	X	X	-	X
hvac_component_definition	-	-	X	-	-	X	X	-	X
hvac_connector	-	-	X	-	-	X	X	-	X
hvac_cross_section	-	-	X	-	-	X	X	-	X
hvac_fitting_class	-	-	X	-	-	X	X	-	X
hvac_plant_item_branch_connection	-	-	X	-	-	X	X	-	X
hvac_plant_item_connection	-	-	X	-	-	X	X	-	X
hvac_section_segment_definition	-	-	X	-	-	X	X	-	X
hvac_section_segment_termination	-	-	X	-	-	X	X	-	X
hvac_system	P	P	P	P	P	P	P	P	P
hvac_system_section_definition	-	-	X	-	-	X	X	-	X
hvac_termination_connection	-	-	X	-	-	X	X	-	X
hybrid_shape_representation	-	A,C	A,C	A,C	A,C	A,C	A,C	A,C	A,C
hyperbola	X	X	X	X	X	X	X	X	X

**Table 3 - Conformance class (1 –9) elements cont'd.**

AIM element	Conformance class								
	1	2	3	4	5	6	7	8	9
id_attribute	-	-	-	-	-	-	-	-	-
identification_assignment	X	X	X	X	X	X	X	X	X
identification_role	X	X	X	X	X	X	X	X	X
inline_equipment	X	X	X	X	X	-	-	-	X
instrumentation_and_control_system	P	P	P	P	P	P	P	P	P
interfering_shape_element	X	X	X	X	X	X	X	X	X
intersection_curve	S	A,C,S	A,C,S	A,C,S	A,C,S	A,C,S	A,C,S	A,C,S	A,C,S
item_identified_representation_usage	X	X	X	X	X	X	X	X	X
known_source	X	X	X	X	X	X	X	X	X
length_measure_with_unit	X	X	X	X	X	X	X	X	X
length_unit	X	X	X	X	X	X	X	X	X
line	X	X	X	X	X	X	X	X	X
line_branch_connection	X	X	X	-	-	-	-	-	X
line_less_piping_system	P	P	P	P	P	P	P	P	P
line_plant_item_branch_connection	X	X	X	-	-	-	-	-	X
line_plant_item_connection	X	X	X	-	-	-	-	-	X
line_termination_connection	X	X	X	-	-	-	-	-	X
local_time	X	X	X	X	X	X	X	X	X
loop	S	A,C,S	A,C,S	A,C,S	A,C,S	A,C,S	A,C,S	A,C,S	A,C,S
luminous_intensity_measure_with_unit	X	X	X	X	X	X	X	X	X
luminous_intensity_unit	X	X	X	X	X	X	X	X	X
make_from_usage_option	X	X	X	X	X	X	X	X	X
manifold_solid_brep	-	A,C	A,C	A,C	A,C	A,C	A,C	A,C	A,C
mapped_item	X	X	X	X	X	X	X	X	X
mass_measure_with_unit	X	X	X	X	X	X	X	X	X
mass_unit	X	X	X	X	X	X	X	X	X
material_designation	X	X	X	X	X	X	X	X	X
material_designation_characterization	X	X	X	X	X	X	X	X	X
material_property	X	X	X	X	X	X	X	X	X
material_property_representation	X	X	X	X	X	X	X	X	X
measure_representation_item	X	X	X	X	X	X	X	X	X
measure_with_unit	X	X	X	X	X	X	X	X	X
name_assignment	R	R	R	R	R	R	R	R	R
name_attribute	-	-	-	-	-	-	-	-	-
named_unit	X	X	X	X	X	X	X	X	X
object_role	R	R	R	R	R	R	R	R	R
offset_curve_2d	X	X	X	X	X	X	X	X	X
offset_curve_3d	X	X	X	X	X	X	X	X	X
offset_surface	S	A,C,S	A,C,S	A,C,S	A,C,S	A,C,S	A,C,S	A,C,S	A,C,S
open_shell	S	A,C,S	A,C,S	A,C,S	A,C,S	A,C,S	A,C,S	A,C,S	A,C,S

**Table 3 - Conformance class (1 –9) elements cont'd.**

AIM element	Conformance class								
	1	2	3	4	5	6	7	8	9
organization	X	X	X	X	X	X	X	X	X
organization_assignment	X	X	X	X	X	X	X	X	X
organization_role	X	X	X	X	X	X	X	X	X
organizational_project	X	X	X	X	X	X	X	X	X
oriented_closed_shell	S	A,C,S	A,C,S	A,C,S	A,C,S	A,C,S	A,C,S	A,C,S	A,C,S
oriented_edge	S	A,C,S	A,C,S	A,C,S	A,C,S	A,C,S	A,C,S	A,C,S	A,C,S
oriented_face	S	A,C,S	A,C,S	A,C,S	A,C,S	A,C,S	A,C,S	A,C,S	A,C,S
oriented_open_shell	S	A,C,S	A,C,S	A,C,S	A,C,S	A,C,S	A,C,S	A,C,S	A,C,S
oriented_path	S	A,C,S	A,C,S	A,C,S	A,C,S	A,C,S	A,C,S	A,C,S	A,C,S
outer_boundary_curve	S	A,C,S	A,C,S	A,C,S	A,C,S	A,C,S	A,C,S	A,C,S	A,C,S
parabola	X	X	X	X	X	X	X	X	X
parametric_representation_context	S	A,C,S	A,C,S	A,C,S	A,C,S	A,C,S	A,C,S	A,C,S	A,C,S
path	S	A,C,S	A,C,S	A,C,S	A,C,S	A,C,S	A,C,S	A,C,S	A,C,S
pcurve	S	A,C,S	A,C,S	A,C,S	A,C,S	A,C,S	A,C,S	A,C,S	A,C,S
person	X	X	X	X	X	X	X	X	X
person_and_organization	X	X	X	X	X	X	X	X	X
person_and_organization_assignment	X	X	X	X	X	X	X	X	X
person_and_organization_role	X	X	X	X	X	X	X	X	X
person_assignment	X	X	X	X	X	X	X	X	X
person_role	X	X	X	X	X	X	X	X	X
pipe_class	X	X	X	X	X	-	-	-	X
pipe_closure_fitting_class	X	X	X	X	X	-	-	-	X
piping_component_class	X	X	X	X	X	-	-	-	X
piping_component_definition	X	X	X	X	X	X	X	X	X
piping_connector_class	X	X	X	X	X	-	-	-	X
piping_spool_definition	X	X	X	X	X	-	-	-	X
piping_support_definition	X	X	X	X	X	-	-	-	X
piping_support_fitting_class	X	X	X	X	X	-	-	-	X
piping_system	P	P	P	P	P	P	P	P	P
placement	X	X	X	X	X	X	X	X	X
plane	S	A,C,S	A,C,S	A,C,S	A,C,S	A,C,S	A,C,S	A,C,S	A,C,S
plane_angle_measure_with_unit	X	X	X	X	X	X	X	X	X
plane_angle_unit	X	X	X	X	X	X	X	X	X
plant	P	P	P	P	P	P	P	P	P
plant_csg_shape_representation	-	B,C	B,C	B,C	B,C	-	B,C	B,C	-
plant_design_csg_primitive	-	B,C	B,C	B,C	B,C	-	B,C	B,C	-
plant_item_connection	X	X	X	X	X	X	X	X	X
plant_item_connector	X	X	X	X	X	X	X	X	X
plant_item_interference	X	X	X	X	X	X	X	X	X
plant_item_route	X	X	X	X	X	X	X	X	X

**Table 3 - Conformance class (1 –9) elements cont'd.**

AIM element	Conformance class								
	1	2	3	4	5	6	7	8	9
plant_item_weight_representation	X	X	X	X	X	X	X	X	X
plant_line_definition	X	X	X	-	-	-	-	-	X
plant_line_segment_definition	X	X	X	-	-	-	-	-	X
plant_line_segment_termination	X	X	X	-	-	-	-	-	X
plant_spatial_configuration_change_assignment	R	R	R	R	R	R	R	R	R
plant_spatial_configuration_organization_assignment	X	X	X	X	X	X	X	X	X
plant_spatial_configuration_person_and_organization_assignment	P,S,R	P,S,R	P,S,R	P,S,R	P,S,R	P,S,R	P,S,R	P,S,R	P,S,R
plant_spatial_configuration_person_assignment	X	X	X	X	X	X	X	X	X
point	X	X	X	X	X	X	X	X	X
point_on_curve	X	X	X	X	X	X	X	X	X
point_on_surface	S	A,C,S	A,C,S	A,C,S	A,C,S	A,C,S	A,C,S	A,C,S	A,C,S
point_replica	X	X	X	X	X	X	X	X	X
poly_loop	X	X	X	X	X	X	X	X	X
polyline	X	X	X	X	X	X	X	X	X
pre_defined_item	X	X	X	X	X	X	X	X	X
precision_qualifier	X	X	X	X	X	X	X	X	X
presentation_layer_assignment	X	X	X	X	X	X	X	X	X
process_capability	P	P	P	P	P	P	P	P	P
product	X	X	X	X	X	X	X	X	X
product_context	X	X	X	X	X	X	X	X	X
product_definition	X	X	X	X	X	X	X	X	X
product_definition_context	X	X	X	X	X	X	X	X	X
product_definition_formation	X	X	X	X	X	X	X	X	X
product_definition_formation_relationship	X	X	X	X	X	X	X	X	X
product_definition_formation_with_specified_source	X	X	X	X	X	X	X	X	X
product_definition_relationship	X	X	X	X	X	X	X	X	X
product_definition_shape	X	X	X	X	X	X	X	X	X
product_definition_substitute	X	X	X	X	X	X	X	X	X
product_definition_usage	X	X	X	X	X	X	X	X	X
product_definition_with_associated_documents	X	X	X	-	-	-	-	-	X
product_material_composition_relationship	X	X	X	X	X	X	X	X	X
property_definition	X	X	X	X	X	X	X	X	X
property_definition_relationship	X	X	X	X	X	X	X	X	X
property_definition_representation	X	X	X	X	X	X	X	X	X
purchase_assignment	X	X	X	X	X	X	X	X	X

**Table 3 - Conformance class (1 –9) elements cont'd.**

AIM element	Conformance class								
	1	2	3	4	5	6	7	8	9
qualified_representation_item	X	X	X	X	X	X	X	X	X
quasi_uniform_curve	X	X	X	X	X	X	X	X	X
quasi_uniform_surface	S	A,C,S	A,C,S	A,C,S	A,C,S	A,C,S	A,C,S	A,C,S	A,C,S
ratio_measure_with_unit	X	X	X	X	X	X	X	X	X
ratio_unit	X	X	X	X	X	X	X	X	X
rational_b_spline_curve	X	X	X	X	X	X	X	X	X
rational_b_spline_surface	S	A,C,S	A,C,S	A,C,S	A,C,S	A,C,S	A,C,S	A,C,S	A,C,S
rectangular_composite_surface	S	A,C,S	A,C,S	A,C,S	A,C,S	A,C,S	A,C,S	A,C,S	A,C,S
rectangular_pyramid	-	B,C	B,C	B,C	B,C	-	B,C	B,C	-
rectangular_trimmed_surface	S	A,C,S	A,C,S	A,C,S	A,C,S	A,C,S	A,C,S	A,C,S	A,C,S
reducer_fitting_class	X	X	X	X	X	-	-	-	X
reference_geometry	X	X	X	X	X	X	X	X	X
reinforcing_component_definition	X	X	X	X	X	-	-	-	X
reparametrised_composite_curve_segment	X	X	X	X	X	X	X	X	X
representation	X	X	X	X	X	X	X	X	X
representation_context	X	X	X	X	X	X	X	X	X
representation_item	X	X	X	X	X	X	X	X	X
representation_item_relationship	X	X	X	X	X	X	X	X	X
representation_map	X	X	X	X	X	X	X	X	X
required_material_property	X	X	X	X	X	X	X	X	X
reserved_space	X	X	X	X	X	X	X	X	X
revolved_area_solid	-	A,C	A,C	A,C	A,C	A,C	A,C	A,C	A,C
revolved_face_solid	-	A,C	A,C	A,C	A,C	A,C	A,C	A,C	A,C
right_angular_wedge	-	B,C	B,C	B,C	B,C	-	B,C	B,C	-
right_circular_cone	-	B,C	B,C	B,C	B,C	-	B,C	B,C	-
right_circular_cylinder	-	B,C	B,C	B,C	B,C	-	B,C	B,C	-
role_association	R	R	R	R	R	R	R	R	R
seam_curve	S	A,C,S	A,C,S	A,C,S	A,C,S	A,C,S	A,C,S	A,C,S	A,C,S
shape_aspect	X	X	X	X	X	X	X	X	X
shape_aspect_deriving_relationship	X	X	X	X	X	X	X	X	X
shape_aspect_relationship	X	X	X	X	X	X	X	X	X
shape_definition_representation	X	X	X	X	X	X	X	X	X
shape_dimension_representation	X	X	X	X	X	X	X	X	X
shape_representation	X	X	X	X	X	X	X	X	X
shell_based_wireframe_model	-	A,C	A,C	A,C	A,C	A,C	A,C	A,C	A,C
si_unit	X	X	X	X	X	X	X	X	X
site	S	S	S	S	S	S	S	S	S
site_building	S	S	S	S	S	S	S	S	S
site_feature	S	S	S	S	S	S	S	S	S
site_representation	S	S	S	S	S	S	S	S	S

**Table 3 - Conformance class (1 –9) elements cont'd.**

AIM element	Conformance class								
	1	2	3	4	5	6	7	8	9
sited_plant	S	S	S	S	S	S	S	S	S
solid_angle_measure_with_unit	X	X	X	X	X	X	X	X	X
solid_angle_unit	X	X	X	X	X	X	X	X	X
solid_model	-	B,C	B,C	B,C	B,C	-	B,C	B,C	-
spacer_fitting_class	X	X	X	X	X	-	-	-	X
specialty_item_class	X	X	X	X	X	-	-	-	X
sphere	-	B,C	B,C	B,C	B,C	-	B,C	B,C	-
spherical_surface	S	A,C,S	A,C,S	A,C,S	A,C,S	A,C,S	A,C,S	A,C,S	A,C,S
stream_design_case	X	X	X	-	-	X	X	-	X
stream_phase	X	X	X	-	-	-	-	-	X
structural_load_connector_class	X	X	X	X	X	X	X	X	X
structural_system	P	P	P	P	P	P	P	P	P
support_constraint_representation	X	X	X	X	X	X	X	X	X
surface	S	A,C,S	A,C,S	A,C,S	A,C,S	A,C,S	A,C,S	A,C,S	A,C,S
surface_curve	S	A,C,S	A,C,S	A,C,S	A,C,S	A,C,S	A,C,S	A,C,S	A,C,S
surface_of_linear_extrusion	S	A,C,S	A,C,S	A,C,S	A,C,S	A,C,S	A,C,S	A,C,S	A,C,S
surface_of_revolution	S	A,C,S	A,C,S	A,C,S	A,C,S	A,C,S	A,C,S	A,C,S	A,C,S
surface_patch	S	A,C,S	A,C,S	A,C,S	A,C,S	A,C,S	A,C,S	A,C,S	A,C,S
surface_replica	S	A,C,S	A,C,S	A,C,S	A,C,S	A,C,S	A,C,S	A,C,S	A,C,S
swage_fitting_class	X	X	X	X	X	-	-	-	X
swept_area_solid	-	A,C	A,C	A,C	A,C	A,C	A,C	A,C	A,C
swept_face_solid	-	A,C	A,C	A,C	A,C	A,C	A,C	A,C	A,C
swept_surface	S	A,C,S	A,C,S	A,C,S	A,C,S	A,C,S	A,C,S	A,C,S	A,C,S
symmetric_shape_aspect	X	X	X	X	X	X	X	X	X
system_class	P	P	P	P	P	P	P	P	P
system_space	X	X	X	X	X	X	X	X	X
thermodynamic_temperature_measure_with_unit	X	X	X	X	X	X	X	X	X
thermodynamic_temperature_unit	X	X	X	X	X	X	X	X	X
time_measure_with_unit	X	X	X	X	X	X	X	X	X
time_unit	X	X	X	X	X	X	X	X	X
topological_representation_item	S	A,C,S	A,C,S	A,C,S	A,C,S	A,C,S	A,C,S	A,C,S	A,C,S
toroidal_surface	S	A,C,S	A,C,S	A,C,S	A,C,S	A,C,S	A,C,S	A,C,S	A,C,S
torus	-	B,C	B,C	B,C	B,C	-	B,C	B,C	-
trimmed_curve	X	X	X	X	X	X	X	X	X
type_qualifier	X	X	X	X	X	X	X	X	X
uniform_curve	X	X	X	X	X	X	X	X	X
uniform_surface	S	A,C,S	A,C,S	A,C,S	A,C,S	A,C,S	A,C,S	A,C,S	A,C,S
valve_class	X	X	X	X	X	-	-	-	X
vector	X	X	X	X	X	X	X	X	X

**Table 3 - Conformance class (1 –9) elements cont'd.**

<b>AIM element</b>	<b>Conformance class</b>								
	<b>1</b>	<b>2</b>	<b>3</b>	<b>4</b>	<b>5</b>	<b>6</b>	<b>7</b>	<b>8</b>	<b>9</b>
versioned_action_request	X	X	X	X	X	X	X	X	X
vertex	S	A,C,S	A,C,S	A,C,S	A,C,S	A,C,S	A,C,S	A,C,S	A,C,S
vertex_loop	S	A,C,S	A,C,S	A,C,S	A,C,S	A,C,S	A,C,S	A,C,S	A,C,S
vertex_point	S	A,C,S	A,C,S	A,C,S	A,C,S	A,C,S	A,C,S	A,C,S	A,C,S
vertex_shell	S	A,C,S	A,C,S	A,C,S	A,C,S	A,C,S	A,C,S	A,C,S	A,C,S
wire_shell	-	A,C	A,C	A,C	A,C	A,C	A,C	A,C	A,C

## Annex A

(normative)

### AIM EXPRESS expanded listing

The following EXPRESS is the expanded form of the short form schema given in 5.2. In the event of any discrepancy between the short form and this expanded listing, the expanded listing shall be used.

\*)

SCHEMA plant\_spatial\_configuration;

CONSTANT

dummy\_gri : geometric\_representation\_item := representation\_item("") ||  
geometric\_representation\_item();

dummy\_tri : topological\_representation\_item := representation\_item("")  
|| topological\_representation\_item();

END\_CONSTANT;

TYPE action\_request\_item = SELECT

(product);

END\_TYPE; -- action\_request\_item

TYPE ahead\_or\_behind = ENUMERATION OF

(ahead,  
exact,  
behind);

END\_TYPE; -- ahead\_or\_behind

TYPE amount\_of\_substance\_measure = REAL;

END\_TYPE; -- amount\_of\_substance\_measure

TYPE angle\_relator = ENUMERATION OF

(equal,  
large,  
small);

END\_TYPE; -- angle\_relator

TYPE approval\_item = SELECT

(change\_action,  
piping\_system,  
versioned\_action\_request);

END\_TYPE; -- approval\_item

TYPE area\_measure = REAL;

END\_TYPE; -- area\_measure

TYPE axis2\_placement = SELECT

```
(axis2_placement_2d,  
  axis2_placement_3d);  
END_TYPE; -- axis2_placement
```

```
TYPE b_spline_curve_form = ENUMERATION OF  
  (polyline_form,  
   circular_arc,  
   elliptic_arc,  
   parabolic_arc,  
   hyperbolic_arc,  
   unspecified);  
END_TYPE; -- b_spline_curve_form
```

```
TYPE b_spline_surface_form = ENUMERATION OF  
  (plane_surf,  
   cylindrical_surf,  
   conical_surf,  
   spherical_surf,  
   toroidal_surf,  
   surf_of_revolution,  
   ruled_surf,  
   generalised_cone,  
   quadric_surf,  
   surf_of_linear_extrusion,  
   unspecified);  
END_TYPE; -- b_spline_surface_form
```

```
TYPE boolean_operand = SELECT  
  (solid_model,  
   half_space_solid,  
   csg_primitive,  
   boolean_result);  
END_TYPE; -- boolean_operand
```

```
TYPE boolean_operator = ENUMERATION OF  
  (union,  
   intersection,  
   difference);  
END_TYPE; -- boolean_operator
```

```
TYPE change_item = SELECT  
  (assembly_component_usage,  
   axis2_placement_2d,  
   axis2_placement_3d,  
   document,  
   ducting_system,  
   electrical_system,  
   externally_defined_plant_item_definition,  
   instrumentation_and_control_system,  
   line_branch_connection,  
   line_plant_item_branch_connection,
```

```

line_plant_item_connection,
line_termination_connection,
piping_system,
plant,
plant_item_connection,
plant_item_connector,
plant_line_definition,
plant_line_segment_definition,
plant_line_segment_termination,
process_capability,
product,
product_definition,
product_definition_relationship,
product_definition_shape,
property_definition,
reference_geometry,
site,
site_feature,
sited_plant,
structural_system);
END_TYPE; -- change_item

```

```

TYPE change_life_cycle_item = SELECT
  (directed_action);
END_TYPE; -- change_life_cycle_item

```

```

TYPE characterized_definition = SELECT
  (characterized_object,
   characterized_product_definition,
   shape_definition);
END_TYPE; -- characterized_definition

```

```

TYPE characterized_material_property = SELECT
  (material_property_representation,
   product_material_composition_relationship);
END_TYPE; -- characterized_material_property

```

```

TYPE characterized_product_definition = SELECT
  (product_definition,
   product_definition_relationship);
END_TYPE; -- characterized_product_definition

```

```

TYPE classification_item = SELECT
  (cableway_system,
   ducting_system,
   electrical_system,
   hvac_component_definition,
   hvac_connector,
   instrumentation_and_control_system,
   piping_component_definition,
   piping_system,
   plant_item_connection,
   plant_item_connector,
   applied_document_reference,

```

```
    product,  
    product_definition,  
    structural_system);  
END_TYPE; -- classification_item
```

```
TYPE context_dependent_measure = REAL;  
END_TYPE; -- context_dependent_measure
```

```
TYPE count_measure = NUMBER;  
END_TYPE; -- count_measure
```

```
TYPE csg_primitive = SELECT  
    (sphere,  
     ellipsoid,  
     block,  
     right_angular_wedge,  
     rectangular_pyramid,  
     torus,  
     right_circular_cone,  
     eccentric_cone,  
     right_circular_cylinder,  
     cyclide_segment_solid);  
END_TYPE; -- csg_primitive
```

```
TYPE csg_select = SELECT  
    (boolean_result,  
     csg_primitive);  
END_TYPE; -- csg_select
```

```
TYPE curve_on_surface = SELECT  
    (pcurve,  
     surface_curve,  
     composite_curve_on_surface);  
END_TYPE; -- curve_on_surface
```

```
TYPE date_and_time_item = SELECT  
    (change_action,  
     change_item,  
     change_life_cycle_stage_assignment,  
     product);  
END_TYPE; -- date_and_time_item
```

```
TYPE date_time_or_event_occurrence = SELECT  
    (date_time_select);  
END_TYPE; -- date_time_or_event_occurrence
```

```
TYPE date_time_select = SELECT  
    (date,  
     local_time,  
     date_and_time);  
END_TYPE; -- date_time_select
```

```

TYPE dated_item = SELECT
  (action_directive,
   change_action,
   change_item,
   product);
END_TYPE; -- dated_item

```

```

TYPE day_in_month_number = INTEGER;
WHERE
  wr1: ((1 <= SELF) AND (SELF <= 31));
END_TYPE; -- day_in_month_number

```

```

TYPE derived_property_select = SELECT
  (property_definition);
END_TYPE; -- derived_property_select

```

```

TYPE description_attribute_select = SELECT
  (action_request_solution,
   application_context,
   approval_role,
   date_role,
   date_time_role,
   external_source,
   organization_role,
   person_and_organization_role,
   person_and_organization,
   person_role,
   property_definition_representation,
   representation);
END_TYPE; -- description_attribute_select

```

```

TYPE design_project_item = SELECT
  (product_definition);
END_TYPE; -- design_project_item

```

```

TYPE dimension_count = INTEGER;
WHERE
  wr1: (SELF > 0);
END_TYPE; -- dimension_count

```

```

TYPE dimensional_characteristic = SELECT
  (dimensional_location,
   dimensional_size);
END_TYPE; -- dimensional_characteristic

```

```

TYPE document_item = SELECT
  (externally_defined_plant_item_definition,
   heat_tracing_representation,
   material_property,
   piping_component_class,
   piping_system,
   plant_item_connector,
   plant_line_segment_definition,

```

```

    product,
    product_definition,
    product_definition_relationship,
    property_definition,
    representation,
    representation_item,
    site);
END_TYPE; -- document_item

TYPE electric_current_measure = REAL;
END_TYPE; -- electric_current_measure

TYPE founded_item_select = SELECT
    (founded_item,
     representation_item);
END_TYPE; -- founded_item_select

TYPE geometric_set_select = SELECT
    (point,
     curve,
     surface);
END_TYPE; -- geometric_set_select

TYPE hour_in_day = INTEGER;
WHERE
    wr1: ((0 <= SELF) AND (SELF < 24));
END_TYPE; -- hour_in_day

TYPE id_attribute_select = SELECT
    (action,
     property_definition,
     shape_aspect,
     shape_aspect_relationship,
     application_context,
     group,
     organizational_project,
     representation);
END_TYPE; -- id_attribute_select

TYPE identified_item = SELECT
    (document,
     material_property,
     product_definition,
     shape_aspect);
END_TYPE; -- identified_item

TYPE identifier = STRING;
END_TYPE; -- identifier

TYPE knot_type = ENUMERATION OF
    (uniform_knots,
```

```

    quasi_uniform_knots,
    piecewise_bezier_knots,
    unspecified);
END_TYPE; -- knot_type

```

```

TYPE label = STRING;
END_TYPE; -- label

```

```

TYPE layered_item = SELECT
    (representation_item);
END_TYPE; -- layered_item

```

```

TYPE length_measure = REAL;
END_TYPE; -- length_measure

```

```

TYPE list_of_reversible_topology_item = LIST OF reversible_topology_item;
END_TYPE; -- list_of_reversible_topology_item

```

```

TYPE luminous_intensity_measure = REAL;
END_TYPE; -- luminous_intensity_measure

```

```

TYPE mass_measure = REAL;
END_TYPE; -- mass_measure

```

```

TYPE measure_value = SELECT
    (length_measure,
     mass_measure,
     time_measure,
     electric_current_measure,
     thermodynamic_temperature_measure,
     amount_of_substance_measure,
     luminous_intensity_measure,
     plane_angle_measure,
     solid_angle_measure,
     area_measure,
     volume_measure,
     ratio_measure,
     parameter_value,
     numeric_measure,
     context_dependent_measure,
     positive_length_measure,
     positive_plane_angle_measure,
     positive_ratio_measure,
     count_measure);
END_TYPE; -- measure_value

```

```

TYPE minute_in_hour = INTEGER;
WHERE
    wr1: ((0 <= SELF) AND (SELF <= 59));
END_TYPE; -- minute_in_hour

```

```

TYPE month_in_year_number = INTEGER;
WHERE
    wr1: ((1 <= SELF) AND (SELF <= 12));
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```

END\_TYPE; -- month\_in\_year\_number

TYPE name\_attribute\_select = SELECT  
  (action\_request\_solution,  
  derived\_unit,  
  person\_and\_organization,  
  product\_definition,  
  product\_definition\_substitute,  
  property\_definition\_representation);  
END\_TYPE; -- name\_attribute\_select

TYPE numeric\_measure = NUMBER;  
END\_TYPE; -- numeric\_measure

TYPE parameter\_value = REAL;  
END\_TYPE; -- parameter\_value

TYPE pcurve\_or\_surface = SELECT  
  (pcurve,  
  surface);  
END\_TYPE; -- pcurve\_or\_surface

TYPE person\_organization\_select = SELECT  
  (person,  
  organization,  
  person\_and\_organization);  
END\_TYPE; -- person\_organization\_select

TYPE plane\_angle\_measure = REAL;  
END\_TYPE; -- plane\_angle\_measure

TYPE plant\_spatial\_configuration\_organization\_item = SELECT  
  (catalogue,  
  change\_action,  
  design\_project,  
  document,  
  plant,  
  product\_definition\_formation,  
  product\_definition\_relationship,  
  representation,  
  site);  
END\_TYPE; -- plant\_spatial\_configuration\_organization\_item

TYPE plant\_spatial\_configuration\_person\_and\_organization\_item = SELECT  
  (change\_item,  
  plant,  
  site);  
END\_TYPE; -- plant\_spatial\_configuration\_person\_and\_organization\_item

TYPE plant\_spatial\_configuration\_person\_item = SELECT  
  (document,

```

    plant,
    product_definition_relationship,
    representation,
    site);
END_TYPE; -- plant_spatial_configuration_person_item

TYPE positive_length_measure = length_measure;
WHERE
    wr1: (SELF > 0);
END_TYPE; -- positive_length_measure

TYPE positive_plane_angle_measure = plane_angle_measure;
WHERE
    wr1: (SELF > 0);
END_TYPE; -- positive_plane_angle_measure

TYPE positive_ratio_measure = ratio_measure;
WHERE
    wr1: (SELF > 0);
END_TYPE; -- positive_ratio_measure

TYPE preferred_surface_curve_representation = ENUMERATION OF
    (curve_3d,
    pcurve_s1,
    pcurve_s2);
END_TYPE; -- preferred_surface_curve_representation

TYPE purchase_item = SELECT
    (product);
END_TYPE; -- purchase_item

TYPE ratio_measure = REAL;
END_TYPE; -- ratio_measure

TYPE represented_definition = SELECT
    (property_definition,
    property_definition_relationship,
    shape_aspect,
    shape_aspect_relationship);
END_TYPE; -- represented_definition

TYPE reversible_topology = SELECT
    (reversible_topology_item,
    list_of_reversible_topology_item,
    set_of_reversible_topology_item);
END_TYPE; -- reversible_topology

TYPE reversible_topology_item = SELECT
    (edge,
    path,
    face,
    face_bound,
    closed_shell,
    open_shell);
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```

```
END_TYPE; -- reversible_topology_item
```

```
TYPE role_select = SELECT
  (action_assignment,
   action_request_assignment,
   approval_assignment,
   approval_date_time,
   document_reference,
   group_assignment,
   name_assignment);
END_TYPE; -- role_select
```

```
TYPE second_in_minute = REAL;
WHERE
  wr1: ((0 <= SELF) AND (SELF <= 60));
END_TYPE; -- second_in_minute
```

```
TYPE set_of_reversible_topology_item = SET OF reversible_topology_item;
END_TYPE; -- set_of_reversible_topology_item
```

```
TYPE shape_definition = SELECT
  (product_definition_shape,
   shape_aspect,
   shape_aspect_relationship);
END_TYPE; -- shape_definition
```

```
TYPE shell = SELECT
  (vertex_shell,
   wire_shell,
   open_shell,
   closed_shell);
END_TYPE; -- shell
```

```
TYPE si_prefix = ENUMERATION OF
  (exa,
   peta,
   tera,
   giga,
   mega,
   kilo,
   hecto,
   deca,
   deci,
   centi,
   milli,
   micro,
   nano,
   pico,
   femto,
   atto);
END_TYPE; -- si_prefix
```

```

TYPE si_unit_name = ENUMERATION OF
(metre,
 gram,
 second,
 ampere,
 kelvin,
 mole,
 candela,
 radian,
 steradian,
 hertz,
 newton,
 pascal,
 joule,
 watt,
 coulomb,
 volt,
 farad,
 ohm,
 siemens,
 weber,
 tesla,
 henry,
 degree_celsius,
 lumen,
 lux,
 becquerel,
 gray,
 sievert);
END_TYPE; -- si_unit_name

```

```

TYPE solid_angle_measure = REAL;
END_TYPE; -- solid_angle_measure

```

```

TYPE source = ENUMERATION OF
(made,
 bought,
 not_known);
END_TYPE; -- source

```

```

TYPE source_item = SELECT
(identifier);
END_TYPE; -- source_item

```

```

TYPE supported_item = SELECT
(action_directive,
 action,
 action_method);
END_TYPE; -- supported_item

```

```

TYPE surface_boundary = SELECT
(boundary_curve,
 degenerate_pcurve);

```

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```
END_TYPE; -- surface_boundary

TYPE text = STRING;
END_TYPE; -- text

TYPE thermodynamic_temperature_measure = REAL;
END_TYPE; -- thermodynamic_temperature_measure

TYPE time_measure = REAL;
END_TYPE; -- time_measure

TYPE transformation = SELECT
  (functionally_defined_transformation);
END_TYPE; -- transformation

TYPE transition_code = ENUMERATION OF
  (discontinuous,
   continuous,
   cont_same_gradient,
   cont_same_gradient_same_curvature);
END_TYPE; -- transition_code

TYPE trimming_preference = ENUMERATION OF
  (cartesian,
   parameter,
   unspecified);
END_TYPE; -- trimming_preference

TYPE trimming_select = SELECT
  (cartesian_point,
   parameter_value);
END_TYPE; -- trimming_select

TYPE unit = SELECT
  (named_unit,
   derived_unit);
END_TYPE; -- unit

TYPE value_qualifier = SELECT
  (precision_qualifier,
   type_qualifier);
END_TYPE; -- value_qualifier

TYPE vector_or_direction = SELECT
  (vector,
   direction);
END_TYPE; -- vector_or_direction

TYPE volume_measure = REAL;
END_TYPE; -- volume_measure
```

```

TYPE wireframe_model = SELECT
  (shell_based_wireframe_model);
END_TYPE; -- wireframe_model

```

```

TYPE year_number = INTEGER;
END_TYPE; -- year_number

```

```

ENTITY action;
  name      : label;
  description : OPTIONAL text;
  chosen_method : action_method;
  DERIVE
    id : identifier := get_id_value(SELF);
  WHERE
    wr1: (SIZEOF(USEDIN(SELF,'PLANT_SPATIAL_CONFIGURATION.' +
      'ID_ATTRIBUTE.IDENTIFIED_ITEM')) <= 1);
END_ENTITY; -- action

```

```

ENTITY action_assignment
  ABSTRACT SUPERTYPE;
  assigned_action : action;
  DERIVE
    role : object_role := get_role(SELF);
  WHERE
    wr1: (SIZEOF(USEDIN(SELF,'PLANT_SPATIAL_CONFIGURATION.' +
      'ROLE_ASSOCIATION.ITEM_WITH_ROLE')) <= 1);
END_ENTITY; -- action_assignment

```

```

ENTITY action_directive;
  name      : label;
  description : OPTIONAL text;
  analysis   : text;
  comment    : text;
  requests   : SET [1:?] OF versioned_action_request;
END_ENTITY; -- action_directive

```

```

ENTITY action_method;
  name      : label;
  description : OPTIONAL text;
  consequence : text;
  purpose    : text;
END_ENTITY; -- action_method

```

```

ENTITY action_method_relationship;
  name      : label;
  description : OPTIONAL text;
  relating_method : action_method;
  related_method : action_method;
END_ENTITY; -- action_method_relationship

```

```

ENTITY action_relationship;
  name      : label;
  description : OPTIONAL text;
  relating_action : action;
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```

```

    related_action : action;
END_ENTITY; -- action_relationship

```

```

ENTITY action_request_assignment
  ABSTRACT SUPERTYPE;
  assigned_action_request : versioned_action_request;
  DERIVE
    role : object_role := get_role(SELF);
  WHERE
    wr1: (SIZEOF(USEDIN(SELF,'PLANT_SPATIAL_CONFIGURATION.' +
      'ROLE_ASSOCIATION.ITEM_WITH_ROLE')) <= 1);
END_ENTITY; -- action_request_assignment

```

```

ENTITY action_request_solution;
  method : action_method;
  request : versioned_action_request;
  DERIVE
    description : text := get_description_value(SELF);
    name : label := get_name_value(SELF);
  WHERE
    wr1: (SIZEOF(USEDIN(SELF,'PLANT_SPATIAL_CONFIGURATION.' +
      'DESCRIPTION_ATTRIBUTE.DESCRIBED_ITEM')) <= 1);
    wr2: (SIZEOF(USEDIN(SELF,'PLANT_SPATIAL_CONFIGURATION.' +
      'NAME_ATTRIBUTE.NAMED_ITEM')) <= 1);
END_ENTITY; -- action_request_solution

```

```

ENTITY action_request_status;
  status : label;
  assigned_request : versioned_action_request;
END_ENTITY; -- action_request_status

```

```

ENTITY action_status;
  status : label;
  assigned_action : executed_action;
END_ENTITY; -- action_status

```

```

ENTITY amount_of_substance_measure_with_unit
  SUBTYPE OF (measure_with_unit);
  WHERE
    wr1: ('PLANT_SPATIAL_CONFIGURATION.AMOUNT_OF_SUBSTANCE_UNIT' IN
    TYPEOF(SELF\
      measure_with_unit.unit_component));
END_ENTITY; -- amount_of_substance_measure_with_unit

```

```

ENTITY amount_of_substance_unit
  SUBTYPE OF (named_unit);
  WHERE
    wr1: ((SELF\named_unit.dimensions.length_exponent = 0) AND (SELF\
      named_unit.dimensions.mass_exponent = 0) AND (SELF\
      named_unit.dimensions.time_exponent = 0) AND (SELF\
      named_unit.dimensions.electric_current_exponent = 0) AND (

```

```

        SELF\named_unit.dimensions.
        thermodynamic_temperature_exponent = 0) AND (SELF\named_unit
        .dimensions.amount_of_substance_exponent = 1) AND (SELF\
        named_unit.dimensions.luminous_intensity_exponent = 0));
END_ENTITY; -- amount_of_substance_unit

```

```

ENTITY angular_location
  SUBTYPE OF (dimensional_location);
  angle_selection : angle_relator;
END_ENTITY; -- angular_location

```

```

ENTITY application_context;
  application : label;
  DERIVE
    description : text := get_description_value(SELF);
    id          : identifier := get_id_value(SELF);
  INVERSE
    context_elements : SET [1:?] OF application_context_element FOR
      frame_of_reference;
  WHERE
    wr1: (SIZEOF(USEDIN(SELF,'PLANT_SPATIAL_CONFIGURATION.' +
      'DESCRIPTION_ATTRIBUTE.DESCRIBED_ITEM')) <= 1);
    wr2: (SIZEOF(USEDIN(SELF,'PLANT_SPATIAL_CONFIGURATION.' +
      'ID_ATTRIBUTE.IDENTIFIED_ITEM')) <= 1);
END_ENTITY; -- application_context

```

```

ENTITY application_context_element
  SUPERTYPE OF (ONEOF (product_context,product_definition_context));
  name          : label;
  frame_of_reference : application_context;
END_ENTITY; -- application_context_element

```

```

ENTITY application_protocol_definition;
  status          : label;
  application_interpreted_model_schema_name : label;
  application_protocol_year : year_number;
  application      : application_context;
END_ENTITY; -- application_protocol_definition

```

```

ENTITY applied_action_request_assignment
  SUBTYPE OF (action_request_assignment);
  items : SET [1:?] OF action_request_item;
END_ENTITY; -- applied_action_request_assignment

```

```

ENTITY applied_approval_assignment
  SUBTYPE OF (approval_assignment);
  items : SET [1:?] OF approval_item;
END_ENTITY; -- applied_approval_assignment

```

```

ENTITY applied_classification_assignment
  SUBTYPE OF (classification_assignment);
  items : SET [1:?] OF classification_item;
  WHERE
    wr1: ((NOT (SIZEOF(QUERY ( item <* SELF.items | (NOT (
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```

```

    'PLANT_SPATIAL_CONFIGURATION.PLANT_ITEM_CONNECTION' IN
    TYPEOF(item))) )) = 0)) OR (SIZEOF(TYPEOF(SELF.
    assigned_class) * [
    'PLANT_SPATIAL_CONFIGURATION.CONNECTION_FUNCTIONAL_CLASS',
    'PLANT_SPATIAL_CONFIGURATION.CONNECTION_MOTION_CLASS']) >= 1));
wr2: ((NOT (SIZEOF(QUERY ( item <* SELF.items | (NOT (
    'PLANT_SPATIAL_CONFIGURATION.PLANT_ITEM_CONNECTOR' IN
    TYPEOF(item))) )) = 0)) OR (SIZEOF(TYPEOF(SELF.
    assigned_class) * [
    'PLANT_SPATIAL_CONFIGURATION.CONNECTOR_END_TYPE_CLASS',
    'PLANT_SPATIAL_CONFIGURATION.ELECTRICAL_CONNECTOR_CLASS',
    'PLANT_SPATIAL_CONFIGURATION.PIPING_CONNECTOR_CLASS',
    'PLANT_SPATIAL_CONFIGURATION.EXTERNALLY_DEFINED_CLASS',
    'PLANT_SPATIAL_CONFIGURATION.' +
    'STRUCTURAL_LOAD_CONNECTOR_CLASS']) >= 1));
wr3: ((NOT (SIZEOF(QUERY ( item <* SELF.items | (NOT (
    'PLANT_SPATIAL_CONFIGURATION.PIPING_COMPONENT_DEFINITION' IN
    TYPEOF(item))) )) = 0)) OR (SIZEOF(TYPEOF(SELF.
    assigned_class) * [
    'PLANT_SPATIAL_CONFIGURATION.BLANK_FITTING_CLASS',
    'PLANT_SPATIAL_CONFIGURATION.ELBOW_FITTING_CLASS',
    'PLANT_SPATIAL_CONFIGURATION.FLANGE_FITTING_CLASS',
    'PLANT_SPATIAL_CONFIGURATION.' +
    'FLANGE_FITTING_NECK_TYPE_CLASS',
    'PLANT_SPATIAL_CONFIGURATION.PIPE_CLOSURE_FITTING_CLASS',
    'PLANT_SPATIAL_CONFIGURATION.PIPE_CLASS',
    'PLANT_SPATIAL_CONFIGURATION.REDUCER_FITTING_CLASS',
    'PLANT_SPATIAL_CONFIGURATION.SPACER_FITTING_CLASS',
    'PLANT_SPATIAL_CONFIGURATION.SPECIALTY_ITEM_CLASS',
    'PLANT_SPATIAL_CONFIGURATION.SWAGE_FITTING_CLASS',
    'PLANT_SPATIAL_CONFIGURATION.VALVE_CLASS']) >= 1));
END_ENTITY; -- applied_classification_assignment

ENTITY applied_date_and_time_assignment
  SUBTYPE OF (date_and_time_assignment);
  items : SET [1:?] OF date_and_time_item;
END_ENTITY; -- applied_date_and_time_assignment

ENTITY applied_date_assignment
  SUBTYPE OF (date_assignment);
  items : SET [1:?] OF dated_item;
END_ENTITY; -- applied_date_assignment

ENTITY applied_document_reference
  SUBTYPE OF (document_reference);
  items : SET [1:?] OF document_item;
END_ENTITY; -- applied_document_reference

ENTITY applied_identification_assignment
  SUBTYPE OF (identification_assignment);
  items : SET [1:?] OF identified_item;

```

```

WHERE
  wr1: applied_identification_correlation(SELF);
END_ENTITY; -- applied_identification_assignment

ENTITY approval;
  status : approval_status;
  level : label;
END_ENTITY; -- approval

ENTITY approval_assignment
  ABSTRACT SUPERTYPE;
  assigned_approval : approval;
  DERIVE
    role : object_role := get_role(SELF);
  WHERE
    wr1: (SIZEOF(USEDIN(SELF,'PLANT_SPATIAL_CONFIGURATION.' +
      'ROLE_ASSOCIATION.ITEM_WITH_ROLE')) <= 1);
END_ENTITY; -- approval_assignment

ENTITY approval_date_time;
  date_time : date_time_select;
  dated_approval : approval;
  DERIVE
    role : object_role := get_role(SELF);
  WHERE
    wr1: (SIZEOF(USEDIN(SELF,'PLANT_SPATIAL_CONFIGURATION.' +
      'ROLE_ASSOCIATION.ITEM_WITH_ROLE')) <= 1);
END_ENTITY; -- approval_date_time

ENTITY approval_person_organization;
  person_organization : person_organization_select;
  authorized_approval : approval;
  role : approval_role;
END_ENTITY; -- approval_person_organization

ENTITY approval_role;
  role : label;
  DERIVE
    description : text := get_description_value(SELF);
  WHERE
    wr1: (SIZEOF(USEDIN(SELF,'PLANT_SPATIAL_CONFIGURATION.' +
      'DESCRIPTION_ATTRIBUTE.DESCRIBED_ITEM')) <= 1);
END_ENTITY; -- approval_role

ENTITY approval_status;
  name : label;
END_ENTITY; -- approval_status

ENTITY assembly_component_usage
  SUBTYPE OF (product_definition_usage);
  reference_designator : OPTIONAL identifier;
END_ENTITY; -- assembly_component_usage

ENTITY axis1_placement

```

```

SUBTYPE OF (placement);
  axis : OPTIONAL direction;
DERIVE
  z : direction := NVL(normalise(axis),dummy_gri || direction([0,0,1]));
WHERE
  wr1: (SELF\geometric_representation_item.dim = 3);
END_ENTITY; -- axis1_placement

ENTITY axis2_placement_2d
SUBTYPE OF (placement);
  ref_direction : OPTIONAL direction;
DERIVE
  p : LIST [2:2] OF direction := build_2axes(ref_direction);
WHERE
  wr1: (SELF\geometric_representation_item.dim = 2);
END_ENTITY; -- axis2_placement_2d

ENTITY axis2_placement_3d
SUBTYPE OF (placement);
  axis      : OPTIONAL direction;
  ref_direction : OPTIONAL direction;
DERIVE
  p : LIST [3:3] OF direction := build_axes(axis,ref_direction);
WHERE
  wr1: (SELF\placement.location.dim = 3);
  wr2: ((NOT EXISTS(axis)) OR (axis.dim = 3));
  wr3: ((NOT EXISTS(ref_direction)) OR (ref_direction.dim = 3));
  wr4: ((NOT EXISTS(axis)) OR (NOT EXISTS(ref_direction)) OR (
    cross_product(axis,ref_direction).magnitude > 0));
END_ENTITY; -- axis2_placement_3d

ENTITY b_spline_curve
SUPERTYPE OF (ONEOF (uniform_curve,b_spline_curve_with_knots,
  quasi_uniform_curve,bezier_curve) ANDOR rational_b_spline_curve)
SUBTYPE OF (bounded_curve);
  degree      : INTEGER;
  control_points_list : LIST [2:?] OF cartesian_point;
  curve_form   : b_spline_curve_form;
  closed_curve : LOGICAL;
  self_intersect : LOGICAL;
DERIVE
  upper_index_on_control_points : INTEGER := SIZEOF(
    control_points_list) - 1;
  control_points : ARRAY [0:100] OF cartesian_point :=
    list_to_array(control_points_list,
    0,upper_index_on_control_points);
WHERE
  wr1: (('PLANT_SPATIAL_CONFIGURATION.UNIFORM_CURVE' IN TYPEOF(SELF))
OR (
  'PLANT_SPATIAL_CONFIGURATION.QUASI_UNIFORM_CURVE' IN
  TYPEOF(SELF)) OR (

```

```

    'PLANT_SPATIAL_CONFIGURATION.BEZIER_CURVE' IN TYPEOF(SELF)) OR (
    'PLANT_SPATIAL_CONFIGURATION.B_SPLINE_CURVE_WITH_KNOTS' IN
    TYPEOF(SELF)));
    END_ENTITY; -- b_spline_curve

```

```

ENTITY b_spline_curve_with_knots
    SUBTYPE OF (b_spline_curve);
    knot_multiplicities : LIST [2:?] OF INTEGER;
    knots               : LIST [2:?] OF parameter_value;
    knot_spec           : knot_type;
    DERIVE
        upper_index_on_knots : INTEGER := SIZEOF(knots);
    WHERE
        wr1: constraints_param_b_spline(degree,upper_index_on_knots,
            upper_index_on_control_points,knot_multiplicities,knots);
        wr2: (SIZEOF(knot_multiplicities) = upper_index_on_knots);
    END_ENTITY; -- b_spline_curve_with_knots

```

```

ENTITY b_spline_surface
    SUPERTYPE OF (ONEOF (b_spline_surface_with_knots,uniform_surface,
        quasi_uniform_surface,bezier_surface) ANDOR
        rational_b_spline_surface)
    SUBTYPE OF (bounded_surface);
    u_degree      : INTEGER;
    v_degree      : INTEGER;
    control_points_list : LIST [2:?] OF LIST [2:?] OF cartesian_point;
    surface_form   : b_spline_surface_form;
    u_closed       : LOGICAL;
    v_closed       : LOGICAL;
    self_intersect  : LOGICAL;
    DERIVE
        u_upper      : INTEGER := SIZEOF(control_points_list) - 1;
        v_upper      : INTEGER := SIZEOF(control_points_list[1]) - 1;
        control_points : ARRAY [0:100] OF ARRAY [0:100] OF cartesian_point
            := make_array_of_array(control_points_list,0,
                u_upper,0,v_upper);
    WHERE
        wr1: (('PLANT_SPATIAL_CONFIGURATION.UNIFORM_SURFACE' IN
    TYPEOF(SELF)) OR (
        'PLANT_SPATIAL_CONFIGURATION.QUASI_UNIFORM_SURFACE' IN
        TYPEOF(SELF)) OR
        ('PLANT_SPATIAL_CONFIGURATION.BEZIER_SURFACE' IN TYPEOF(SELF))
    OR
        ('PLANT_SPATIAL_CONFIGURATION.B_SPLINE_SURFACE_WITH_KNOTS' IN
        TYPEOF(SELF)));
    END_ENTITY; -- b_spline_surface

```

```

ENTITY b_spline_surface_with_knots
    SUBTYPE OF (b_spline_surface);
    u_multiplicities : LIST [2:?] OF INTEGER;
    v_multiplicities : LIST [2:?] OF INTEGER;
    u_knots          : LIST [2:?] OF parameter_value;
    v_knots          : LIST [2:?] OF parameter_value;
    knot_spec        : knot_type;
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```

## DERIVE

knot\_u\_upper : INTEGER := SIZEOF(u\_knots);

knot\_v\_upper : INTEGER := SIZEOF(v\_knots);

## WHERE

wr1: constraints\_param\_b\_spline(SELF\b\_spline\_surface.u\_degree,  
knot\_u\_upper,SELF\b\_spline\_surface.u\_upper,u\_multiplicities,  
u\_knots);

wr2: constraints\_param\_b\_spline(SELF\b\_spline\_surface.v\_degree,  
knot\_v\_upper,SELF\b\_spline\_surface.v\_upper,v\_multiplicities,  
v\_knots);

wr3: (SIZEOF(u\_multiplicities) = knot\_u\_upper);

wr4: (SIZEOF(v\_multiplicities) = knot\_v\_upper);

END\_ENTITY; -- b\_spline\_surface\_with\_knots

## ENTITY bezier\_curve

SUBTYPE OF (b\_spline\_curve);

END\_ENTITY; -- bezier\_curve

## ENTITY bezier\_surface

SUBTYPE OF (b\_spline\_surface);

END\_ENTITY; -- bezier\_surface

## ENTITY blank\_fitting\_class

SUBTYPE OF (group);

## WHERE

wr1: (SIZEOF(QUERY ( aca <\* QUERY ( ca <\* USEDIN(SELF,  
'PLANT\_SPATIAL\_CONFIGURATION.CLASSIFICATION\_ASSIGNMENT.' +  
'ASSIGNED\_CLASS') |

('PLANT\_SPATIAL\_CONFIGURATION.APPLIED\_CLASSIFICATION\_ASSIGNMENT'  
IN TYPEOF(ca)) ) | (NOT (SIZEOF(QUERY ( it <\* aca.items | (  
NOT (  
'PLANT\_SPATIAL\_CONFIGURATION.PIPING\_COMPONENT\_DEFINITION' IN  
TYPEOF(it))) )) = 0)) )) = 0);

wr2: (SIZEOF(QUERY ( aca <\* QUERY ( ca <\* USEDIN(SELF,  
'PLANT\_SPATIAL\_CONFIGURATION.CLASSIFICATION\_ASSIGNMENT.' +  
'ASSIGNED\_CLASS') |

('PLANT\_SPATIAL\_CONFIGURATION.APPLIED\_CLASSIFICATION\_ASSIGNMENT'  
IN TYPEOF(ca)) ) | (NOT (SIZEOF(QUERY ( pcd <\*  
QUERY ( it <\* aca.items | (  
'PLANT\_SPATIAL\_CONFIGURATION.PIPING\_COMPONENT\_DEFINITION' IN  
TYPEOF(it)) ) | (NOT (SIZEOF(QUERY ( aca1 <\* USEDIN(pcd.  
formation.of\_product,'PLANT\_SPATIAL\_CONFIGURATION.' +  
'APPLIED\_CLASSIFICATION\_ASSIGNMENT.ITEMS') | class\_in\_tree(  
aca1.assigned\_class,'blank') )) = 1)) )) = 0)) )) = 0);

END\_ENTITY; -- blank\_fitting\_class

## ENTITY block

SUBTYPE OF (geometric\_representation\_item);

position : axis2\_placement\_3d;

```

x      : positive_length_measure;
y      : positive_length_measure;
z      : positive_length_measure;
END_ENTITY; -- block

```

```

ENTITY bolt_and_nut_component_class

```

```

  SUBTYPE OF (group);

```

```

  WHERE

```

```

    wr1: (SIZEOF(QUERY ( aca <* QUERY ( ca <* USEDIN(SELF,
      'PLANT_SPATIAL_CONFIGURATION.CLASSIFICATION_ASSIGNMENT.' +
      'ASSIGNED_CLASS') |

```

```

('PLANT_SPATIAL_CONFIGURATION.APPLIED_CLASSIFICATION_ASSIGNMENT'
  IN TYPEOF(ca)) ) | (NOT (SIZEOF(QUERY ( it <* aca.items | (
  NOT

```

```

('PLANT_SPATIAL_CONFIGURATION.BOLT_AND_NUT_COMPONENT_DEFINITION'
  IN TYPEOF(it))) )) = 0)) )) = 0);

```

```

    wr2: (SIZEOF(QUERY ( aca <* QUERY ( ca <* USEDIN(SELF,
      'PLANT_SPATIAL_CONFIGURATION.CLASSIFICATION_ASSIGNMENT.' +
      'ASSIGNED_CLASS') |

```

```

('PLANT_SPATIAL_CONFIGURATION.APPLIED_CLASSIFICATION_ASSIGNMENT'
  IN TYPEOF(ca)) ) | (NOT (SIZEOF(QUERY ( pcd <*
  QUERY ( it <* aca.items |

```

```

('PLANT_SPATIAL_CONFIGURATION.BOLT_AND_NUT_COMPONENT_DEFINITION'
  IN TYPEOF(it)) ) | (NOT (SIZEOF(QUERY ( aca1 <* USEDIN(pcd.
  formation.of_product,'PLANT_SPATIAL_CONFIGURATION.' +
  'APPLIED_CLASSIFICATION_ASSIGNMENT.ITEMS') | class_in_tree(
  aca1.assigned_class,'bolt and nut component') )) = 1)) )) =
  0)) )) = 0);

```

```

END_ENTITY; -- bolt_and_nut_component_class

```

```

ENTITY bolt_and_nut_component_definition

```

```

  SUBTYPE OF (product_definition);

```

```

END_ENTITY; -- bolt_and_nut_component_definition

```

```

ENTITY bolt_and_nut_set_definition

```

```

  SUBTYPE OF (product_definition);

```

```

END_ENTITY; -- bolt_and_nut_set_definition

```

```

ENTITY boolean_result

```

```

  SUBTYPE OF (geometric_representation_item);

```

```

    operator      : boolean_operator;

```

```

    first_operand : boolean_operand;

```

```

    second_operand : boolean_operand;

```

```

END_ENTITY; -- boolean_result

```

```

ENTITY boundary_curve

```

```

  SUBTYPE OF (composite_curve_on_surface);

```

```

  WHERE

```

```

    wr1: SELF\composite_curve.closed_curve;

```

```

END_ENTITY; -- boundary_curve

```

```

ENTITY bounded_curve
  SUPERTYPE OF (ONEOF (polyline,b_spline_curve,trimmed_curve,
    bounded_pcurve,bounded_surface_curve,composite_curve))
  SUBTYPE OF (curve);
END_ENTITY; -- bounded_curve

ENTITY bounded_pcurve
  SUBTYPE OF (pcurve, bounded_curve);
  WHERE
    wr1: ('PLANT_SPATIAL_CONFIGURATION.BOUNDED_CURVE' IN
TYPEOF(SELF\pcurve.
  reference_to_curve.items[1]));
END_ENTITY; -- bounded_pcurve

ENTITY bounded_surface
  SUPERTYPE OF (ONEOF (b_spline_surface,rectangular_trimmed_surface,
    curve_bounded_surface,rectangular_composite_surface))
  SUBTYPE OF (surface);
END_ENTITY; -- bounded_surface

ENTITY bounded_surface_curve
  SUBTYPE OF (surface_curve, bounded_curve);
  WHERE
    wr1: ('PLANT_SPATIAL_CONFIGURATION.BOUNDED_CURVE' IN
TYPEOF(SELF\surface_curve.
  curve_3d));
END_ENTITY; -- bounded_surface_curve

ENTITY brep_with_voids
  SUBTYPE OF (manifold_solid_brep);
  voids : SET [1:?] OF oriented_closed_shell;
END_ENTITY; -- brep_with_voids

ENTITY cableway_component_class
  SUBTYPE OF (group);
  WHERE
    wr1: (SIZEOF(QUERY ( aca <* QUERY ( ca <* USEDIN(SELF,
      'PLANT_SPATIAL_CONFIGURATION.' +
      'CLASSIFICATION_ASSIGNMENT.ASSIGNED_CLASS') |
('PLANT_SPATIAL_CONFIGURATION.APPLIED_CLASSIFICATION_ASSIGNMENT'
  IN TYPEOF(ca)) ) | (NOT (SIZEOF(QUERY ( it <* aca.items | (
    NOT (
'PLANT_SPATIAL_CONFIGURATION.CABLEWAY_COMPONENT_DEFINITION'
  IN TYPEOF(it))) ) = 0)) ) = 0);
    wr2: (SIZEOF(QUERY ( aca <* QUERY ( ca <* USEDIN(SELF,
      'PLANT_SPATIAL_CONFIGURATION.CLASSIFICATION_ASSIGNMENT.' +
      'ASSIGNED_CLASS') |

```

```

('PLANT_SPATIAL_CONFIGURATION.APPLIED_CLASSIFICATION_ASSIGNMENT'
  IN TYPEOF(ca)) ) | (NOT (SIZEOF(QUERY ( pcd < *
    QUERY ( it < * aca.items | (
      'PLANT_SPATIAL_CONFIGURATION.PIPING_COMPONENT_DEFINITION' IN
      TYPEOF(it)) ) | (NOT (SIZEOF(QUERY ( aca1 < * USEDIN(pcd.
      formation.of_product,'PLANT_SPATIAL_CONFIGURATION.' +
      'APPLIED_CLASSIFICATION_ASSIGNMENT.ITEMS') | class_in_tree(
      aca1.assigned_class,'cableway component') )) = 1)) )) = 0)) ))
    = 0);
END_ENTITY; -- cableway_component_class

ENTITY cableway_component_definition
  SUBTYPE OF (product_definition);
END_ENTITY; -- cableway_component_definition

ENTITY cableway_connector_class
  SUBTYPE OF (group);
END_ENTITY; -- cableway_connector_class

ENTITY cableway_system
  SUBTYPE OF (product_definition);
  WHERE
    wr1: (SIZEOF(QUERY ( pdr < * USEDIN(SELF,
      'PLANT_SPATIAL_CONFIGURATION.' +
      'PRODUCT_DEFINITION_RELATIONSHIP.RELATED_PRODUCT_DEFINITION')
      | (('PLANT_SPATIAL_CONFIGURATION.PLANT' IN TYPEOF(pdr.
      relating_product_definition.formation.of_product)) AND (pdr.
      relating_product_definition.frame_of_reference.name =
      'functional occurrence')) )) = 1);
END_ENTITY; -- cableway_system

ENTITY calendar_date
  SUBTYPE OF (date);
  day_component : day_in_month_number;
  month_component : month_in_year_number;
  WHERE
    wr1: valid_calendar_date(SELF);
END_ENTITY; -- calendar_date

ENTITY cartesian_point
  SUBTYPE OF (point);
  coordinates : LIST [1:3] OF length_measure;
END_ENTITY; -- cartesian_point

ENTITY cartesian_transformation_operator
  SUPERTYPE OF (ONEOF (cartesian_transformation_operator_3d))
  SUBTYPE OF (geometric_representation_item,
    functionally_defined_transformation);
  axis1 : OPTIONAL direction;
  axis2 : OPTIONAL direction;
  local_origin : cartesian_point;
  scale : OPTIONAL REAL;
  DERIVE
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```

```

    scl : REAL := NVL(scale,1);
  WHERE
    wr1: (scl > 0);
END_ENTITY; -- cartesian_transformation_operator

```

```

ENTITY cartesian_transformation_operator_3d
  SUBTYPE OF (cartesian_transformation_operator);
  axis3 : OPTIONAL direction;
  DERIVE
    u : LIST [3:3] OF direction := base_axis(3,SELF\
      cartesian_transformation_operator.axis1,SELF\
      cartesian_transformation_operator.axis2,axis3);
  WHERE
    wr1: (SELF\geometric_representation_item.dim = 3);
END_ENTITY; -- cartesian_transformation_operator_3d

```

```

ENTITY catalogue
  SUBTYPE OF (document, external_source);
END_ENTITY; -- catalogue

```

```

ENTITY catalogue_connector
  SUBTYPE OF (shape_aspect, externally_defined_item);
  WHERE
    wr1: ('PLANT_SPATIAL_CONFIGURATION.CHARACTERIZED_OBJECT' IN TYPEOF(
      SELF.of_shape));
    wr2: ('PLANT_SPATIAL_CONFIGURATION.CATALOGUE' IN TYPEOF(SELF.source));
END_ENTITY; -- catalogue_connector

```

```

ENTITY catalogue_item
  SUBTYPE OF (externally_defined_plant_item_definition);
  WHERE
    wr1: ('PLANT_SPATIAL_CONFIGURATION.CATALOGUE' IN TYPEOF(SELF.source));
    wr2: (SELF.frame_of_reference.name = 'catalogue definition');
END_ENTITY; -- catalogue_item

```

```

ENTITY centre_of_symmetry
  SUBTYPE OF (derived_shape_aspect);
  WHERE
    wr1: (SIZEOF(QUERY ( sadr <* SELF\derived_shape_aspect.
      deriving_relationships | (NOT (
        'PLANT_SPATIAL_CONFIGURATION.SYMMETRIC_SHAPE_ASPECT' IN
        TYPEOF(sadr\shape_aspect_relationship.related_shape_aspect))) ))
      = 0);
END_ENTITY; -- centre_of_symmetry

```

```

ENTITY change_action
  SUBTYPE OF (directed_action);
  WHERE
    wr1: (SIZEOF(QUERY ( ca <* USEDIN(SELF,
      'PLANT_SPATIAL_CONFIGURATION.' +
      'ACTION_ASSIGNMENT.ASSIGNED_ACTION') | ((

```

```

    'PLANT_SPATIAL_CONFIGURATION.' +
    'PLANT_SPATIAL_CONFIGURATION_CHANGE_ASSIGNMENT') IN TYPEOF(
    ca)) )) >= 1);
wr2: (SIZEOF(QUERY ( ar < * SELF\directed_action.directive.requests
    | (NOT (SIZEOF(USEDIN(ar,'PLANT_SPATIAL_CONFIGURATION.' +
    'ACTION_REQUEST_SOLUTION.REQUEST')) = 1)) )) = 0);
wr3: (SIZEOF(USEDIN(SELF,
    'PLANT_SPATIAL_CONFIGURATION.ACTION_STATUS.' +
    'ASSIGNED_ACTION')) = 1);
END_ENTITY; -- change_action

ENTITY change_item_id_assignment
    SUBTYPE OF (name_assignment);
    items : SET [1:?] OF change_item;
END_ENTITY; -- change_item_id_assignment

ENTITY change_life_cycle_stage_assignment
    SUBTYPE OF (group_assignment);
    items : SET [1:?] OF change_life_cycle_item;
END_ENTITY; -- change_life_cycle_stage_assignment

ENTITY characterized_object;
    name      : label;
    description : OPTIONAL text;
END_ENTITY; -- characterized_object

ENTITY circle
    SUBTYPE OF (conic);
    radius : positive_length_measure;
END_ENTITY; -- circle

ENTITY classification_assignment
    ABSTRACT SUPERTYPE;
    assigned_class : group;
    role          : classification_role;
END_ENTITY; -- classification_assignment

ENTITY classification_role;
    name      : label;
    description : OPTIONAL text;
END_ENTITY; -- classification_role

ENTITY closed_shell
    SUBTYPE OF (connected_face_set);
END_ENTITY; -- closed_shell

ENTITY colour;
END_ENTITY; -- colour

ENTITY colour_rgb
    SUBTYPE OF (colour_specification);
    red  : REAL;
    green : REAL;
    blue : REAL;
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```

```

WHERE
  wr1: ((0 <= red) AND (red <= 1));
  wr2: ((0 <= green) AND (green <= 1));
  wr3: ((0 <= blue) AND (blue <= 1));
END_ENTITY; -- colour_rgb

ENTITY colour_specification
  SUBTYPE OF (colour);
  name : label;
END_ENTITY; -- colour_specification

ENTITY composite_curve
  SUBTYPE OF (bounded_curve);
  segments : LIST [1:?] OF composite_curve_segment;
  self_intersect : LOGICAL;
  DERIVE
    n_segments : INTEGER := SIZEOF(segments);
    closed_curve : LOGICAL := segments[n_segments].transition <>
      discontinuous;
  WHERE
    wr1: (((NOT closed_curve) AND (SIZEOF(QUERY ( temp <* segments | (
      temp.transition = discontinuous) )) = 1)) OR (closed_curve
      AND (SIZEOF(QUERY ( temp <* segments | (temp.transition =
      discontinuous) )) = 0)));
END_ENTITY; -- composite_curve

ENTITY composite_curve_on_surface
  SUBTYPE OF (composite_curve);
  DERIVE
    basis_surface : SET [0:2] OF surface := get_basis_surface(SELf);
  WHERE
    wr1: (SIZEOF(basis_surface) > 0);
    wr2: constraints_composite_curve_on_surface(SELf);
END_ENTITY; -- composite_curve_on_surface

ENTITY composite_curve_segment
  SUBTYPE OF (founded_item);
  transition : transition_code;
  same_sense : BOOLEAN;
  parent_curve : curve;
  INVERSE
    using_curves : BAG [1:?] OF composite_curve FOR segments;
  WHERE
    wr1: ('PLANT_SPATIAL_CONFIGURATION.BOUNDED_CURVE' IN
      TYPEOF(parent_curve));
END_ENTITY; -- composite_curve_segment

ENTITY conic
  SUPERTYPE OF (ONEOF (circle,ellipse,hyperbola,parabola))
  SUBTYPE OF (curve);
  position : axis2_placement;

```

END\_ENTITY; -- conic

ENTITY conical\_surface  
 SUBTYPE OF (elementary\_surface);  
   radius : length\_measure;  
   semi\_angle : plane\_angle\_measure;  
 WHERE  
   wr1: (radius >= 0);  
 END\_ENTITY; -- conical\_surface

ENTITY connected\_face\_set  
 SUPERTYPE OF (ONEOF (closed\_shell,open\_shell))  
 SUBTYPE OF (topological\_representation\_item);  
   cfs\_faces : SET [1:?] OF face;  
 END\_ENTITY; -- connected\_face\_set

ENTITY clamp\_component\_definition  
 SUBTYPE OF (product\_definition);  
 END\_ENTITY; -- clamp\_component\_definition

ENTITY clamp\_set\_definition  
 SUBTYPE OF (product\_definition);  
 END\_ENTITY; -- clamp\_set\_definition

ENTITY connection\_functional\_class  
 SUBTYPE OF (group);  
 END\_ENTITY; -- connection\_functional\_class

ENTITY connection\_material\_definition  
 SUBTYPE OF (product\_definition);  
 END\_ENTITY; -- connection\_material\_definition

ENTITY connection\_motion\_class  
 SUBTYPE OF (group);  
 WHERE  
   wr1: (SELF.name IN ['flexible','locked orientation']);  
 END\_ENTITY; -- connection\_motion\_class

ENTITY connection\_node  
 SUBTYPE OF (shape\_aspect);  
 WHERE  
   wr1: ('PLANT\_SPATIAL\_CONFIGURATION.PIPING\_SYSTEM' IN TYPEOF(SELF.  
     of\_shape.definition));  
   wr2: (SIZEOF(QUERY ( sar <\* USEDIN(SELF,  
     'PLANT\_SPATIAL\_CONFIGURATION.SHAPE\_ASPECT\_RELATIONSHIP.' +  
     'RELATING\_SHAPE\_ASPECT') | (  
     'PLANT\_SPATIAL\_CONFIGURATION.LINE\_TERMINATION\_CONNECTION' IN  
     TYPEOF(sar)) )) >= 2);  
 END\_ENTITY; -- connection\_node

ENTITY connector\_end\_type\_class  
 SUBTYPE OF (group);  
 END\_ENTITY; -- connector\_end\_type\_class

```
ENTITY context_dependent_unit
  SUBTYPE OF (named_unit);
  name : label;
END_ENTITY; -- context_dependent_unit
```

```
ENTITY conversion_based_unit
  SUBTYPE OF (named_unit);
  name : label;
  conversion_factor : measure_with_unit;
END_ENTITY; -- conversion_based_unit
```

```
ENTITY coordinated_universal_time_offset;
  hour_offset : INTEGER;
  minute_offset : OPTIONAL INTEGER;
  sense : ahead_or_behind;
  DERIVE
    actual_minute_offset : INTEGER := NVL(minute_offset,0);
  WHERE
    wr1: ((0 <= hour_offset) AND (hour_offset < 24));
    wr2: ((0 <= actual_minute_offset) AND (actual_minute_offset <= 59));
    wr3: (NOT (((hour_offset <> 0) OR (actual_minute_offset <> 0)) AND (
      sense = exact)));
END_ENTITY; -- coordinated_universal_time_offset
```

```
ENTITY csg_solid
  SUBTYPE OF (solid_model);
  tree_root_expression : csg_select;
END_ENTITY; -- csg_solid
```

```
ENTITY curve
  SUPERTYPE OF (ONEOF (line,conic,pcurve,surface_curve,offset_curve_2d,
    offset_curve_3d,curve_replica) ANDOR bounded_curve)
  SUBTYPE OF (geometric_representation_item);
END_ENTITY; -- curve
```

```
ENTITY curve_bounded_surface
  SUBTYPE OF (bounded_surface);
  basis_surface : surface;
  boundaries : SET [1:?] OF boundary_curve;
  implicit_outer : BOOLEAN;
  WHERE
    wr1: ((NOT implicit_outer) OR (SIZEOF(QUERY ( temp <* boundaries | (
      'PLANT_SPATIAL_CONFIGURATION.OUTER_BOUNDARY_CURVE' IN
      TYPEOF(temp)) )) = 0));
    wr2: ((NOT implicit_outer) OR
      ('PLANT_SPATIAL_CONFIGURATION.BOUNDED_SURFACE' IN
      TYPEOF(basis_surface)));
    wr3: (SIZEOF(QUERY ( temp <* boundaries | (
      'PLANT_SPATIAL_CONFIGURATION.OUTER_BOUNDARY_CURVE' IN
      TYPEOF(temp)) )) <= 1);
    wr4: (SIZEOF(QUERY ( temp <* boundaries | (temp\
```

```

        composite_curve_on_surface.basis_surface[1] <> SELF.
        basis_surface) )) = 0);
END_ENTITY; -- curve_bounded_surface

```

```

ENTITY curve_replica
  SUBTYPE OF (curve);
  parent_curve : curve;
  transformation : cartesian_transformation_operator;
  WHERE
    wr1: (transformation.dim = parent_curve.dim);
    wr2: acyclic_curve_replica(SELF,parent_curve);
END_ENTITY; -- curve_replica

```

```

ENTITY cyclide_segment_solid
  SUBTYPE OF (geometric_representation_item);
  position : axis2_placement_3d;
  radius1 : positive_length_measure;
  radius2 : positive_length_measure;
  cone_angle1 : plane_angle_measure;
  cone_angle2 : plane_angle_measure;
  turn_angle : plane_angle_measure;
END_ENTITY; -- cyclide_segment_solid

```

```

ENTITY cylindrical_surface
  SUBTYPE OF (elementary_surface);
  radius : positive_length_measure;
END_ENTITY; -- cylindrical_surface

```

```

ENTITY data_environment;
  name : label;
  description : text;
  elements : SET [1:?] OF property_definition_representation;
END_ENTITY; -- data_environment

```

```

ENTITY date
  SUPERTYPE OF (ONEOF (calendar_date));
  year_component : year_number;
END_ENTITY; -- date

```

```

ENTITY date_and_time;
  date_component : date;
  time_component : local_time;
END_ENTITY; -- date_and_time

```

```

ENTITY date_and_time_assignment
  ABSTRACT SUPERTYPE;
  assigned_date_and_time : date_and_time;
  role : date_time_role;
END_ENTITY; -- date_and_time_assignment

```

```

ENTITY date_assignment
  ABSTRACT SUPERTYPE;
  assigned_date : date;
  role : date_role;

```

END\_ENTITY; -- date\_assignment

```
ENTITY date_role;
  name : label;
  DERIVE
    description : text := get_description_value(SELF);
  WHERE
    wr1: (SIZEOF(USEDIN(SELF,'PLANT_SPATIAL_CONFIGURATION.' +
      'DESCRIPTION_ATTRIBUTE.DESCRIBED_ITEM')) <= 1);
END_ENTITY; -- date_role
```

```
ENTITY date_time_role;
  name : label;
  DERIVE
    description : text := get_description_value(SELF);
  WHERE
    wr1: (SIZEOF(USEDIN(SELF,'PLANT_SPATIAL_CONFIGURATION.' +
      'DESCRIPTION_ATTRIBUTE.DESCRIBED_ITEM')) <= 1);
END_ENTITY; -- date_time_role
```

```
ENTITY definitional_representation
  SUBTYPE OF (representation);
  WHERE
    wr1:
('PLANT_SPATIAL_CONFIGURATION.PARAMETRIC_REPRESENTATION_CONTEXT'
IN
  TYPEOF(SELF\representation.context_of_items));
END_ENTITY; -- definitional_representation
```

```
ENTITY degenerate_pcurve
  SUBTYPE OF (point);
  basis_surface : surface;
  reference_to_curve : definitional_representation;
  WHERE
    wr1: (SIZEOF(reference_to_curve\representation.items) = 1);
    wr2: ('PLANT_SPATIAL_CONFIGURATION.CURVE' IN TYPEOF(reference_to_curve\
      representation.items[1]));
    wr3: (reference_to_curve\representation.items[1]\
      geometric_representation_item.dim = 2);
END_ENTITY; -- degenerate_pcurve
```

```
ENTITY degenerate_toroidal_surface
  SUBTYPE OF (toroidal_surface);
  select_outer : BOOLEAN;
  WHERE
    wr1: (major_radius < minor_radius);
END_ENTITY; -- degenerate_toroidal_surface
```

```
ENTITY derived_shape_aspect
  SUPERTYPE OF (ONEOF (centre_of_symmetry))
  SUBTYPE OF (shape_aspect);
```

```

INVERSE
  deriving_relationships : SET [1:?] OF shape_aspect_relationship FOR
    relating_shape_aspect;
WHERE
  wr1: (SIZEOF(QUERY ( dr <* SELF\derived_shape_aspect.
    deriving_relationships | (NOT ((
      'PLANT_SPATIAL_CONFIGURATION.' +
      'SHAPE_ASPECT_DERIVING_RELATIONSHIP') IN TYPEOF(dr))) )) = 0);
END_ENTITY; -- derived_shape_aspect

```

```

ENTITY derived_unit;
  elements : SET [1:?] OF derived_unit_element;
DERIVE
  name : label := get_name_value(SELF);
WHERE
  wr1: ((SIZEOF(elements) > 1) OR ((SIZEOF(elements) = 1) AND (
    elements[1].exponent <> 1)));
  wr2: (SIZEOF(USEDIN(SELF,'PLANT_SPATIAL_CONFIGURATION.' +
    'NAME_ATTRIBUTE.NAMED_ITEM')) <= 1);
END_ENTITY; -- derived_unit

```

```

ENTITY derived_unit_element;
  unit : named_unit;
  exponent : REAL;
END_ENTITY; -- derived_unit_element

```

```

ENTITY description_attribute;
  attribute_value : text;
  described_item : description_attribute_select;
END_ENTITY; -- description_attribute

```

```

ENTITY descriptive_colour
  SUBTYPE OF (colour, descriptive_representation_item);
END_ENTITY; -- descriptive_colour

```

```

ENTITY descriptive_representation_item
  SUBTYPE OF (representation_item);
  description : text;
END_ENTITY; -- descriptive_representation_item

```

```

ENTITY design_project
  SUBTYPE OF (organization);
WHERE
  wr1: (SIZEOF(USEDIN(SELF,'PLANT_SPATIAL_CONFIGURATION.' +
    'ORGANIZATION_ASSIGNMENT.ASSIGNED_ORGANIZATION')) >= 1);
END_ENTITY; -- design_project

```

```

ENTITY design_project_assignment
  SUBTYPE OF (organization_assignment);
  items : SET [1:?] OF design_project_item;
WHERE
  wr1: ('PLANT_SPATIAL_CONFIGURATION.DESIGN_PROJECT' IN TYPEOF(SELF.
    assigned_organization));
END_ENTITY; -- design_project_assignment

```

```
ENTITY dimensional_characteristic_representation;
    dimension      : dimensional_characteristic;
    representation : shape_dimension_representation;
END_ENTITY; -- dimensional_characteristic_representation
```

```
ENTITY dimensional_exponents;
    length_exponent      : REAL;
    mass_exponent        : REAL;
    time_exponent        : REAL;
    electric_current_exponent : REAL;
    thermodynamic_temperature_exponent : REAL;
    amount_of_substance_exponent : REAL;
    luminous_intensity_exponent : REAL;
END_ENTITY; -- dimensional_exponents
```

```
ENTITY dimensional_location
    SUPERTYPE OF (ONEOF (angular_location))
    SUBTYPE OF (shape_aspect_relationship);
END_ENTITY; -- dimensional_location
```

```
ENTITY dimensional_size;
    applies_to : shape_aspect;
    name       : label;
    WHERE
        wr1: (applies_to.product_definitional = TRUE);
END_ENTITY; -- dimensional_size
```

```
ENTITY directed_action
    SUBTYPE OF (executed_action);
    directive : action_directive;
END_ENTITY; -- directed_action
```

```
ENTITY direction
    SUBTYPE OF (geometric_representation_item);
    direction_ratios : LIST [2:3] OF REAL;
    WHERE
        wr1: (SIZEOF(QUERY ( tmp <* direction_ratios | (tmp <> 0) )) > 0);
END_ENTITY; -- direction
```

```
ENTITY document;
    id      : identifier;
    name     : label;
    description : OPTIONAL text;
    kind     : document_type;
    INVERSE
        representation_types : SET OF document_representation_type FOR
            represented_document;
END_ENTITY; -- document
```

```
ENTITY document_reference
```

```

ABSTRACT SUPERTYPE;
  assigned_document : document;
  source            : label;
DERIVE
  role : object_role := get_role(SELF);
WHERE
  wr1: (SIZEOF(USEDIN(SELF,'PLANT_SPATIAL_CONFIGURATION.' +
    'ROLE_ASSOCIATION.ITEM_WITH_ROLE')) <= 1);
END_ENTITY; -- document_reference

ENTITY document_relationship;
  name          : label;
  description    : OPTIONAL text;
  relating_document : document;
  related_document : document;
END_ENTITY; -- document_relationship

ENTITY document_representation_type;
  name          : label;
  represented_document : document;
END_ENTITY; -- document_representation_type

ENTITY document_type;
  product_data_type : label;
END_ENTITY; -- document_type

ENTITY document_usage_constraint;
  source          : document;
  subject_element : label;
  subject_element_value : text;
END_ENTITY; -- document_usage_constraint

ENTITY ducting_system
  SUBTYPE OF (product_definition);
  WHERE
    wr1: (SIZEOF(QUERY ( pdr <= USEDIN(SELF,
      'PLANT_SPATIAL_CONFIGURATION.' +
      'PRODUCT_DEFINITION_RELATIONSHIP.RELATED_PRODUCT_DEFINITION')
      | (('PLANT_SPATIAL_CONFIGURATION.PLANT' IN TYPEOF(pdr.
        relating_product_definition.formation.of_product)) AND (pdr.
        relating_product_definition.frame_of_reference.name =
        'functional occurrence')) ) = 1);
END_ENTITY; -- ducting_system

ENTITY eccentric_cone
  SUBTYPE OF (geometric_representation_item);
  position : axis2_placement_3d;
  semi_axis_1 : positive_length_measure;
  semi_axis_2 : positive_length_measure;
  height : positive_length_measure;
  x_offset : length_measure;
  y_offset : length_measure;
  ratio : REAL;
  WHERE
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```

```

    wr1: (ratio >= 0);
END_ENTITY; -- eccentric_cone

```

```

ENTITY edge
  SUPERTYPE OF (ONEOF (edge_curve, oriented_edge))
  SUBTYPE OF (topological_representation_item);
  edge_start : vertex;
  edge_end : vertex;
END_ENTITY; -- edge

```

```

ENTITY edge_curve
  SUBTYPE OF (edge, geometric_representation_item);
  edge_geometry : curve;
  same_sense : BOOLEAN;
END_ENTITY; -- edge_curve

```

```

ENTITY edge_loop
  SUBTYPE OF (loop, path);
  DERIVE
    ne : INTEGER := SIZEOF(SELF\path.edge_list);
  WHERE
    wr1: (SELF\path.edge_list[1].edge_start := SELF\path.edge_list[ne].
      edge_end);
END_ENTITY; -- edge_loop

```

```

ENTITY elbow_fitting_class
  SUBTYPE OF (group);
  WHERE
    wr1: (SIZEOF(QUERY ( aca <* QUERY ( ca <* USEDIN(SELF,
      'PLANT_SPATIAL_CONFIGURATION.' +
      'CLASSIFICATION_ASSIGNMENT.ASSIGNED_CLASS') |
      ('PLANT_SPATIAL_CONFIGURATION.APPLIED_CLASSIFICATION_ASSIGNMENT'
        IN TYPEOF(ca)) ) | (NOT (SIZEOF(QUERY ( it <* aca.items | (
          NOT (
            'PLANT_SPATIAL_CONFIGURATION.PIPING_COMPONENT_DEFINITION' IN
            TYPEOF(it))) ) = 0)) ) = 0);
    wr2: (SIZEOF(QUERY ( aca <* QUERY ( ca <* USEDIN(SELF,
      'PLANT_SPATIAL_CONFIGURATION.CLASSIFICATION_ASSIGNMENT.' +
      'ASSIGNED_CLASS') |
      ('PLANT_SPATIAL_CONFIGURATION.APPLIED_CLASSIFICATION_ASSIGNMENT'
        IN TYPEOF(ca)) ) | (NOT (SIZEOF(QUERY ( pcd <*
          QUERY ( it <* aca.items | (
            'PLANT_SPATIAL_CONFIGURATION.PIPING_COMPONENT_DEFINITION' IN
            TYPEOF(it)) ) | (NOT (SIZEOF(QUERY ( aca1 <* USEDIN(pcd.
              formation.of_product, 'PLANT_SPATIAL_CONFIGURATION.' +
              'APPLIED_CLASSIFICATION_ASSIGNMENT.ITEMS') | class_in_tree(
                aca1.assigned_class, 'elbow') ) = 1)) ) = 0)) ) = 0);
END_ENTITY; -- elbow_fitting_class

```

```

ENTITY electric_current_measure_with_unit
  SUBTYPE OF (measure_with_unit);
  WHERE
    wr1: ('PLANT_SPATIAL_CONFIGURATION.ELECTRIC_CURRENT_UNIT' IN
TYPEOF(SELF\
  measure_with_unit.unit_component));
END_ENTITY; -- electric_current_measure_with_unit

ENTITY electric_current_unit
  SUBTYPE OF (named_unit);
  WHERE
    wr1: ((SELF\named_unit.dimensions.length_exponent = 0) AND (SELF\
  named_unit.dimensions.mass_exponent = 0) AND (SELF\
  named_unit.dimensions.time_exponent = 0) AND (SELF\
  named_unit.dimensions.electric_current_exponent = 1) AND (
  SELF\named_unit.dimensions.
  thermodynamic_temperature_exponent = 0) AND (SELF\named_unit
  .dimensions.amount_of_substance_exponent = 0) AND (SELF\
  named_unit.dimensions.luminous_intensity_exponent = 0));
END_ENTITY; -- electric_current_unit

ENTITY electrical_connector_class
  SUBTYPE OF (group);
END_ENTITY; -- electrical_connector_class

ENTITY electrical_system
  SUBTYPE OF (product_definition);
  WHERE
    wr1: (SIZEOF(QUERY ( pdr <= USEDIN(SELF,
  'PLANT_SPATIAL_CONFIGURATION.' +
  'PRODUCT_DEFINITION_RELATIONSHIP.RELATED_PRODUCT_DEFINITION')
  | (('PLANT_SPATIAL_CONFIGURATION.PLANT' IN TYPEOF(pdr.
  relating_product_definition.formation.of_product)) AND (pdr.
  relating_product_definition.frame_of_reference.name =
  'functional occurrence')) )) = 1);
END_ENTITY; -- electrical_system

ENTITY elementary_surface
  SUPERTYPE OF (ONEOF (plane,cylindrical_surface,conical_surface,
  spherical_surface,toroidal_surface))
  SUBTYPE OF (surface);
  position : axis2_placement_3d;
END_ENTITY; -- elementary_surface

ENTITY ellipse
  SUBTYPE OF (conic);
  semi_axis_1 : positive_length_measure;
  semi_axis_2 : positive_length_measure;
END_ENTITY; -- ellipse

ENTITY ellipsoid
  SUBTYPE OF (geometric_representation_item);
  position : axis2_placement_3d;
  semi_axis_1 : positive_length_measure;
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```

```

    semi_axis_2 : positive_length_measure;
    semi_axis_3 : positive_length_measure;
END_ENTITY; -- ellipsoid

```

```

ENTITY evaluated_degenerate_pcurve
  SUBTYPE OF (degenerate_pcurve);
    equivalent_point : cartesian_point;
END_ENTITY; -- evaluated_degenerate_pcurve

```

```

ENTITY executed_action
  SUBTYPE OF (action);
END_ENTITY; -- executed_action

```

```

ENTITY external_source;
    source_id : source_item;
  DERIVE
    description : text := get_description_value(SELf);
  WHERE
    wr1: (SIZEOF(USEDIN(SELf,'PLANT_SPATIAL_CONFIGURATION.' +
      'DESCRIPTION_ATTRIBUTE.DESCRIBED_ITEM')) <= 1);
END_ENTITY; -- external_source

```

```

ENTITY externally_defined_class
  SUBTYPE OF (group, externally_defined_item);
  WHERE
    wr1: (SIZEOF(QUERY ( aca <* QUERY ( ca <* USEDIN(SELf,
      'PLANT_SPATIAL_CONFIGURATION.CLASSIFICATION_ASSIGNMENT.' +
      'ASSIGNED_CLASS') |
('PLANT_SPATIAL_CONFIGURATION.APPLIED_CLASSIFICATION_ASSIGNMENT'
  IN TYPEOF(ca)) ) | (NOT (SIZEOF(QUERY ( it <* aca.items | (
  NOT ((SIZEOF(TYPEOF(it) * [
    'PLANT_SPATIAL_CONFIGURATION.ELECTRICAL_SYSTEM',
    'PLANT_SPATIAL_CONFIGURATION.DUCTING_SYSTEM',
'PLANT_SPATIAL_CONFIGURATION.INSTRUMENTATION_AND_CONTROL_SYSTEM'
,
    'PLANT_SPATIAL_CONFIGURATION.PIPING_SYSTEM',
    'PLANT_SPATIAL_CONFIGURATION.PLANT',
    'PLANT_SPATIAL_CONFIGURATION.PLANT_ITEM_CONNECTOR',
    'PLANT_SPATIAL_CONFIGURATION.PIPING_COMPONENT_DEFINITION',
    'PLANT_SPATIAL_CONFIGURATION.STRUCTURAL_SYSTEM']) = 1) OR ((
    'PLANT_SPATIAL_CONFIGURATION.PRODUCT_DEFINITION' IN TYPEOF(
    it)) AND (SIZEOF(QUERY ( pc <* it.formation.of_product.
    frame_of_reference | (pc.discipline_type = 'process plant') ))
    = 1)))) ) = 0)) ) = 0);
END_ENTITY; -- externally_defined_class

ENTITY externally_defined_document
  SUBTYPE OF (document, externally_defined_item);
END_ENTITY; -- externally_defined_document

```

```

ENTITY externally_defined_item;
  item_id : source_item;
  source : external_source;
END_ENTITY; -- externally_defined_item

ENTITY externally_defined_item_relationship;
  name      : label;
  description : OPTIONAL text;
  relating_item : externally_defined_item;
  related_item : externally_defined_item;
END_ENTITY; -- externally_defined_item_relationship

ENTITY externally_defined_plant_item_definition
  SUBTYPE OF (product_definition, externally_defined_item);
END_ENTITY; -- externally_defined_plant_item_definition

ENTITY externally_defined_representation_item
  SUBTYPE OF (representation_item, externally_defined_item);
END_ENTITY; -- externally_defined_representation_item

ENTITY extruded_area_solid
  SUBTYPE OF (swept_area_solid);
  extruded_direction : direction;
  depth              : positive_length_measure;
  WHERE
    wr1: (dot_product(SELF\swept_area_solid.swept_area.basis_surface\
      elementary_surface.position.p[3],extruded_direction) <> 0);
END_ENTITY; -- extruded_area_solid

ENTITY extruded_face_solid
  SUBTYPE OF (swept_face_solid);
  extruded_direction : direction;
  depth              : positive_length_measure;
  WHERE
    wr1: (dot_product(SELF\swept_face_solid.swept_face.face_geometry\
      elementary_surface.position.p[3],extruded_direction) <> 0);
END_ENTITY; -- extruded_face_solid

ENTITY face
  SUPERTYPE OF (ONEOF (face_surface,oriented_face))
  SUBTYPE OF (topological_representation_item);
  bounds : SET [1:?] OF face_bound;
  WHERE
    wr1: (NOT mixed_loop_type_set(list_to_set(list_face_loops(SELF))));
    wr2: (SIZEOF(QUERY ( temp < * bounds | (
      'PLANT_SPATIAL_CONFIGURATION.FACE_OUTER_BOUND' IN
      TYPEOF(temp))
    )) <= 1);
END_ENTITY; -- face

ENTITY face_bound
  SUBTYPE OF (topological_representation_item);
  bound      : loop;
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```

```
orientation : BOOLEAN;
END_ENTITY; -- face_bound
```

```
ENTITY face_outer_bound
  SUBTYPE OF (face_bound);
END_ENTITY; -- face_outer_bound
```

```
ENTITY face_surface
  SUBTYPE OF (face, geometric_representation_item);
  face_geometry : surface;
  same_sense : BOOLEAN;
  WHERE
    wr1: (NOT ('PLANT_SPATIAL_CONFIGURATION.ORIENTED_SURFACE' IN
TYPEOF(
  face_geometry)));
END_ENTITY; -- face_surface
```

```
ENTITY faceted_brep
  SUBTYPE OF (manifold_solid_brep);
END_ENTITY; -- faceted_brep
```

```
ENTITY flange_fitting_class
  SUBTYPE OF (group);
  WHERE
```

```
    wr1: (SIZEOF(QUERY ( aca <* QUERY ( ca <* USEDIN(SELf,
      'PLANT_SPATIAL_CONFIGURATION.' +
      'CLASSIFICATION_ASSIGNMENT.ASSIGNED_CLASS') |
('PLANT_SPATIAL_CONFIGURATION.APPLIED_CLASSIFICATION_ASSIGNMENT'
  IN TYPEOF(ca)) ) | (NOT (SIZEOF(QUERY ( it <* aca.items | (
  NOT (
    'PLANT_SPATIAL_CONFIGURATION.PIPING_COMPONENT_DEFINITION' IN
    TYPEOF(it))) )) = 0)) )) = 0);
    wr2: (SIZEOF(QUERY ( aca <* QUERY ( ca <* USEDIN(SELf,
      'PLANT_SPATIAL_CONFIGURATION.' +
      'CLASSIFICATION_ASSIGNMENT.ASSIGNED_CLASS') |
('PLANT_SPATIAL_CONFIGURATION.APPLIED_CLASSIFICATION_ASSIGNMENT'
  IN TYPEOF(ca)) ) | (NOT (SIZEOF(QUERY ( pcd <*
  QUERY ( it <* aca.items | (
    'PLANT_SPATIAL_CONFIGURATION.PIPING_COMPONENT_DEFINITION' IN
    TYPEOF(it)) ) | (NOT (SIZEOF(QUERY ( aca1 <* USEDIN(pcd.
  formation.of_product,'PLANT_SPATIAL_CONFIGURATION.' +
    'APPLIED_CLASSIFICATION_ASSIGNMENT.ITEMS') | class_in_tree(
    aca1.assigned_class,'flange') )) = 1)) )) = 0)) )) = 0);
END_ENTITY; -- flange_fitting_class
```

```
ENTITY flange_fitting_neck_type_class
  SUBTYPE OF (group);
  WHERE
```

```
    wr1: (SIZEOF(QUERY ( aca <* QUERY ( ca <* USEDIN(SELf,
```

```

    'PLANT_SPATIAL_CONFIGURATION.CLASSIFICATION_ASSIGNMENT.' +
    'ASSIGNED_CLASS') |

('PLANT_SPATIAL_CONFIGURATION.APPLIED_CLASSIFICATION_ASSIGNMENT'
  IN TYPEOF(ca)) ) | (NOT (SIZEOF(QUERY ( it < * aca.items | (
  NOT (
    'PLANT_SPATIAL_CONFIGURATION.PIPING_COMPONENT_DEFINITION' IN
    TYPEOF(it))) )) = 0)) )) = 0);
wr2: (SIZEOF(QUERY ( aca < * QUERY ( ca < * USEDIN(SELF,
  'PLANT_SPATIAL_CONFIGURATION.CLASSIFICATION_ASSIGNMENT.' +
  'ASSIGNED_CLASS') |

('PLANT_SPATIAL_CONFIGURATION.APPLIED_CLASSIFICATION_ASSIGNMENT'
  IN TYPEOF(ca)) ) | (NOT (SIZEOF(QUERY ( pcd < *
  QUERY ( it < * aca.items | (
    'PLANT_SPATIAL_CONFIGURATION.PIPING_COMPONENT_DEFINITION' IN
    TYPEOF(it))) ) | (NOT (SIZEOF(QUERY ( aca1 < * USEDIN(pcd.
  formation.of_product,'PLANT_SPATIAL_CONFIGURATION.' +
  'APPLIED_CLASSIFICATION_ASSIGNMENT.ITEMS') | class_in_tree(
    aca1.assigned_class,'flange') )) = 1)) )) = 0))) )) =
  0);
END_ENTITY; -- flange_fitting_neck_type_class

ENTITY founded_item;
END_ENTITY; -- founded_item

ENTITY functionally_defined_transformation;
  name      : label;
  description : OPTIONAL text;
END_ENTITY; -- functionally_defined_transformation

ENTITY geometric_curve_set
  SUBTYPE OF (geometric_set);
  WHERE
    wr1: (SIZEOF(QUERY ( temp < * SELF\geometric_set.elements | (
      'PLANT_SPATIAL_CONFIGURATION.SURFACE' IN TYPEOF(temp))) )) = 0);
END_ENTITY; -- geometric_curve_set

ENTITY geometric_representation_context
  SUBTYPE OF (representation_context);
  coordinate_space_dimension : dimension_count;
END_ENTITY; -- geometric_representation_context

ENTITY geometric_representation_item
  SUBTYPE OF (representation_item);
  DERIVE
    dim : dimension_count := dimension_of(SELF);
  WHERE
    wr1: (SIZEOF(QUERY ( using_rep < * using_representations(SELF) | (
      NOT
('PLANT_SPATIAL_CONFIGURATION.GEOMETRIC_REPRESENTATION_CONTEXT'
  IN TYPEOF(using_rep.context_of_items))) )) = 0);
END_ENTITY; -- geometric_representation_item

```

```

ENTITY geometric_set
  SUPERTYPE OF (ONEOF (geometric_curve_set,geometric_set_replica))
  SUBTYPE OF (geometric_representation_item);
  elements : SET [1:?] OF geometric_set_select;
END_ENTITY; -- geometric_set

ENTITY geometric_set_replica
  SUBTYPE OF (geometric_set);
  parent_set : geometric_set;
  transformation : cartesian_transformation_operator;
  DERIVE
    SELF\geometric_set.elements : SET [1:?] OF geometric_set_select :=
      build_transformed_set(transformation,
        parent_set);
  WHERE
    wr1: acyclic_set_replica(SELF,parent_set);
END_ENTITY; -- geometric_set_replica

ENTITY global_uncertainty_assigned_context
  SUBTYPE OF (representation_context);
  uncertainty : SET [1:?] OF uncertainty_measure_with_unit;
END_ENTITY; --global_uncertainty_assigned_context

ENTITY global_unit_assigned_context
  SUBTYPE OF (representation_context);
  units : SET [1:?] OF unit;
END_ENTITY; -- global_unit_assigned_context

ENTITY group;
  name : label;
  description : OPTIONAL text;
  DERIVE
    id : identifier := get_id_value(SELF);
  WHERE
    wr1: (SIZEOF(USEDIN(SELF,'PLANT_SPATIAL_CONFIGURATION.' +
      'ID_ATTRIBUTE.IDENTIFIED_ITEM')) <= 1);
END_ENTITY; -- group

ENTITY group_assignment
  ABSTRACT SUPERTYPE;
  assigned_group : group;
  DERIVE
    role : object_role := get_role(SELF);
  WHERE
    wr1: (SIZEOF(USEDIN(SELF,'PLANT_SPATIAL_CONFIGURATION.' +
      'ROLE_ASSOCIATION.ITEM_WITH_ROLE')) <= 1);
END_ENTITY; -- group_assignment

ENTITY group_relationship;
  name : label;
  description : OPTIONAL text;

```

```

relating_group : group;
related_group : group;
END_ENTITY; -- group_relationship

```

```

ENTITY half_space_solid
  SUBTYPE OF (geometric_representation_item);
  base_surface : surface;
  agreement_flag : BOOLEAN;
END_ENTITY; -- half_space_solid

```

```

ENTITY heat_tracing_representation
  SUBTYPE OF (representation);
END_ENTITY; -- heat_tracing_representation

```

```

ENTITY hvac_branch_connection
  SUBTYPE OF (shape_aspect_relationship);
  WHERE
    wr1: (SELF.description = 'branch location');
    wr2:
('PLANT_SPATIAL_CONFIGURATION.HVAC_SECTION_SEGMENT_DEFINITION'
  IN TYPEOF(SELF.relying_shape_aspect.of_shape.definition));
    wr3:
('PLANT_SPATIAL_CONFIGURATION.HVAC_SECTION_SEGMENT_TERMINATION'
  IN TYPEOF(SELF.related_shape_aspect));
END_ENTITY; -- hvac_branch_connection

```

```

ENTITY hvac_component_definition
  SUBTYPE OF (product_definition);
END_ENTITY; -- hvac_component_definition

```

```

ENTITY hvac_connector
  SUBTYPE OF (shape_aspect);
  WHERE
    wr1 : (SELF\shape_aspect.of_shape\property_definition.definition\
      product_definition.frame_of_reference\
      application_context_element.name IN [
        'functional definition','physical definition',
        'functional occurrence','physical occurrence']);
    wr2 : ((NOT (SIZEOF(QUERY ( pd < * USEDIN(SELF,
      'PLANT_SPATIAL_CONFIGURATION.PROPERTY_DEFINITION.DEFINITION')
      | (pd.name = 'hvac service characteristics') )) >= 1)) OR
      (SIZEOF(QUERY ( sc < * QUERY ( pd < * USEDIN(SELF,
      'PLANT_SPATIAL_CONFIGURATION.PROPERTY_DEFINITION.DEFINITION')
      | (pd.name = 'hvac service characteristics') ) | (NOT (
      SIZEOF(QUERY ( pdr < * USEDIN(sc,
      'PLANT_SPATIAL_CONFIGURATION.' +
      'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') | (pdr.
      used_representation.name = 'design service characteristics') ))
      = 1)) )) = 0));
    wr3 : ((NOT (SIZEOF(QUERY ( pd < * USEDIN(SELF,
      'PLANT_SPATIAL_CONFIGURATION.PROPERTY_DEFINITION.DEFINITION')
      | (pd.name = 'hvac service characteristics') )) >= 1)) OR
      (SIZEOF(QUERY ( sc < * QUERY ( pd < * USEDIN(SELF,
      'PLANT_SPATIAL_CONFIGURATION.PROPERTY_DEFINITION.DEFINITION')

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```

| (pd.name = 'hvac service characteristics') ) | (NOT (
  SIZEOF(QUERY ( dsc <* QUERY ( pdr <* USEDIN(sc,
    'PLANT_SPATIAL_CONFIGURATION.' +
    'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') | (pdr.
    used_representation.name = 'design service characteristics') )
    | (SIZEOF(dsc.used_representation.items) >= 2) )) = 1)) ))
= 0));
wr4 : ((NOT (SIZEOF(QUERY ( pd <* USEDIN(SELF,
  'PLANT_SPATIAL_CONFIGURATION.PROPERTY_DEFINITION.DEFINITION')
  | (pd.name = 'hvac service characteristics') )) >= 1)) OR
  (SIZEOF(QUERY ( sc <* QUERY ( pd <* USEDIN(SELF,
    'PLANT_SPATIAL_CONFIGURATION.PROPERTY_DEFINITION.DEFINITION')
    | (pd.name = 'hvac service characteristics') ) | (NOT (
      SIZEOF(QUERY ( dsc <* QUERY ( pdr <* USEDIN(sc,
        'PLANT_SPATIAL_CONFIGURATION.' +
        'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') | (pdr.
        used_representation.name = 'design service characteristics') )
        | ((1 <= SIZEOF(QUERY ( it <* dsc.used_representation.
          items | ((
            'PLANT_SPATIAL_CONFIGURATION.MEASURE_REPRESENTATION_ITEM'
            IN TYPEOF(it)) AND (it.name IN ['pressure',
            'minimum pressure','maximum pressure'])) ))) AND (SIZEOF(
              QUERY ( it <* dsc.used_representation.items | ((
                'PLANT_SPATIAL_CONFIGURATION.MEASURE_REPRESENTATION_ITEM'
                IN TYPEOF(it)) AND (it.name IN ['pressure',
                'minimum pressure','maximum pressure'])) )) <= 2)) )) = 1)) ))
              = 0));
wr5 : ((NOT (SIZEOF(QUERY ( pd <* USEDIN(SELF,
  'PLANT_SPATIAL_CONFIGURATION.PROPERTY_DEFINITION.DEFINITION')
  | (pd.name = 'hvac service characteristics') )) >= 1)) OR
  (SIZEOF(QUERY ( sc <* QUERY ( pd <* USEDIN(SELF,
    'PLANT_SPATIAL_CONFIGURATION.PROPERTY_DEFINITION.DEFINITION')
    | (pd.name = 'hvac service characteristics') ) | (NOT (
      SIZEOF(QUERY ( dsc <* QUERY ( pdr <* USEDIN(sc,
        'PLANT_SPATIAL_CONFIGURATION.' +
        'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') | (pdr.
        used_representation.name = 'design service characteristics') )
        | (SIZEOF(QUERY ( it <* dsc.used_representation.items | ((
          'PLANT_SPATIAL_CONFIGURATION.MEASURE_REPRESENTATION_ITEM'
          IN TYPEOF(it)) AND (it.name = 'pressure')) )) <= 1) )) = 1)) ))
          = 0));
wr6 : ((NOT (SIZEOF(QUERY ( pd <* USEDIN(SELF,
  'PLANT_SPATIAL_CONFIGURATION.PROPERTY_DEFINITION.DEFINITION')
  | (pd.name = 'hvac service characteristics') )) >= 1)) OR
  (SIZEOF(QUERY ( sc <* QUERY ( pd <* USEDIN(SELF,
    'PLANT_SPATIAL_CONFIGURATION.PROPERTY_DEFINITION.DEFINITION')
    | (pd.name = 'hvac service characteristics') ) | (NOT (
      SIZEOF(QUERY ( dsc <* QUERY ( pdr <* USEDIN(sc,
        'PLANT_SPATIAL_CONFIGURATION.' +
        'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') | (pdr.
        used_representation.name = 'design service characteristics') )

```

```

    | (sizeof(QUERY ( it <* dsc.used_representation.items | ((
    'PLANT_SPATIAL_CONFIGURATION.MEASURE_REPRESENTATION_ITEM'
    IN TYPEOF(it)) AND (it.name = 'minimum pressure')) )) <= 1) ))
    = 1)) )) = 0));
wr7 : ((NOT (sizeof(QUERY ( pd <* USEDIN(SELF,
    'PLANT_SPATIAL_CONFIGURATION.PROPERTY_DEFINITION.DEFINITION')
    | (pd.name = 'hvac service characteristics') )) >= 1)) OR
    (sizeof(QUERY ( sc <* QUERY ( pd <* USEDIN(SELF,
    'PLANT_SPATIAL_CONFIGURATION.PROPERTY_DEFINITION.DEFINITION')
    | (pd.name = 'hvac service characteristics') ) | NOT (
    sizeof(QUERY ( dsc <* QUERY ( pdr <* USEDIN(sc,
    'PLANT_SPATIAL_CONFIGURATION.' +
    'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') | (pdr.
    used_representation.name = 'design service characteristics') )
    | (sizeof(QUERY ( it <* dsc.used_representation.items | ((
    'PLANT_SPATIAL_CONFIGURATION.MEASURE_REPRESENTATION_ITEM'
    IN TYPEOF(it)) AND (it.name = 'maximum pressure')) )) <= 1) ))
    = 1)) )) = 0));
wr8 : ((NOT (sizeof(QUERY ( pd <* USEDIN(SELF,
    'PLANT_SPATIAL_CONFIGURATION.PROPERTY_DEFINITION.DEFINITION')
    | (pd.name = 'hvac service characteristics') )) >= 1)) OR
    (sizeof(QUERY ( sc <* QUERY ( pd <* USEDIN(SELF,
    'PLANT_SPATIAL_CONFIGURATION.PROPERTY_DEFINITION.DEFINITION')
    | (pd.name = 'hvac service characteristics') ) | NOT (
    sizeof(QUERY ( dsc <* QUERY ( pdr <* USEDIN(sc,
    'PLANT_SPATIAL_CONFIGURATION.' +
    'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') | (pdr.
    used_representation.name = 'design service characteristics') )
    | ((1 <= sizeof(QUERY ( it <* dsc.used_representation.
    items | ((sizeof(TYPEOF(it) * [
    'PLANT_SPATIAL_CONFIGURATION.MEASURE_REPRESENTATION_ITEM',
    'PLANT_SPATIAL_CONFIGURATION.' +
    'THERMODYNAMIC_TEMPERATURE_MEASURE_WITH_UNIT']) = 2) AND (
    it.name IN ['temperature','minimum temperature',
    'maximum temperature'])) ))) AND (sizeof(QUERY ( it <* dsc.
    used_representation.items | ((sizeof(TYPEOF(it) * [
    'PLANT_SPATIAL_CONFIGURATION.MEASURE_REPRESENTATION_ITEM',
    'PLANT_SPATIAL_CONFIGURATION.' +
    'THERMODYNAMIC_TEMPERATURE_MEASURE_WITH_UNIT']) = 2) AND (
    it.name IN ['temperature','minimum temperature',
    'maximum temperature'])) )) <= 2)) )) = 1)) )) = 0));
wr9 : ((NOT (sizeof(QUERY ( pd <* USEDIN(SELF,
    'PLANT_SPATIAL_CONFIGURATION.PROPERTY_DEFINITION.DEFINITION')
    | (pd.name = 'hvac service characteristics') )) >= 1)) OR
    (sizeof(QUERY ( sc <* QUERY ( pd <* USEDIN(SELF,
    'PLANT_SPATIAL_CONFIGURATION.PROPERTY_DEFINITION.DEFINITION')
    | (pd.name = 'hvac service characteristics') ) | NOT (
    sizeof(QUERY ( dsc <* QUERY ( pdr <* USEDIN(sc,
    'PLANT_SPATIAL_CONFIGURATION.' +
    'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') | (pdr.
    used_representation.name = 'design service characteristics') )
    | (sizeof(QUERY ( it <* dsc.used_representation.items | ((
    sizeof(TYPEOF(it) * [
    'PLANT_SPATIAL_CONFIGURATION.MEASURE_REPRESENTATION_ITEM',

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    'PLANT_SPATIAL_CONFIGURATION.' +
    'THERMODYNAMIC_TEMPERATURE_MEASURE_WITH_UNIT']) = 2) AND (
    it.name = 'temperature')) )) <= 1) )) = 1)) )) = 0));
wr10: ((NOT (SIZEOF(QUERY ( pd < * USEDIN(SELF,
    'PLANT_SPATIAL_CONFIGURATION.PROPERTY_DEFINITION.DEFINITION'
    | (pd.name = 'hvac service characteristics') )) >= 1)) OR
    (SIZEOF(QUERY ( sc < * QUERY ( pd < * USEDIN(SELF,
    'PLANT_SPATIAL_CONFIGURATION.PROPERTY_DEFINITION.DEFINITION'
    | (pd.name = 'hvac service characteristics') ) | (NOT (
    SIZEOF(QUERY ( dsc < * QUERY ( pdr < * USEDIN(sc,
    'PLANT_SPATIAL_CONFIGURATION.' +
    'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION' ) | (pdr.
    used_representation.name = 'design service characteristics') )
    | (SIZEOF(QUERY ( it < * dsc.used_representation.items | ((
    SIZEOF(TYPEOF(it) * [
    'PLANT_SPATIAL_CONFIGURATION.MEASURE_REPRESENTATION_ITEM',
    'PLANT_SPATIAL_CONFIGURATION.' +
    'THERMODYNAMIC_TEMPERATURE_MEASURE_WITH_UNIT']) = 2) AND (
    it.name = 'minimum temperature')) )) <= 1) )) = 1)) )) = 0));
wr11: ((NOT (SIZEOF(QUERY ( pd < * USEDIN(SELF,
    'PLANT_SPATIAL_CONFIGURATION.PROPERTY_DEFINITION.DEFINITION'
    | (pd.name = 'hvac service characteristics') )) >= 1)) OR
    (SIZEOF(QUERY ( sc < * QUERY ( pd < * USEDIN(SELF,
    'PLANT_SPATIAL_CONFIGURATION.PROPERTY_DEFINITION.DEFINITION'
    | (pd.name = 'hvac service characteristics') ) | (NOT (
    SIZEOF(QUERY ( dsc < * QUERY ( pdr < * USEDIN(sc,
    'PLANT_SPATIAL_CONFIGURATION.' +
    'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION' ) | (pdr.
    used_representation.name = 'design service characteristics') )
    | (SIZEOF(QUERY ( it < * dsc.used_representation.items | ((
    SIZEOF(TYPEOF(it) * [
    'PLANT_SPATIAL_CONFIGURATION.MEASURE_REPRESENTATION_ITEM',
    'PLANT_SPATIAL_CONFIGURATION.' +
    'THERMODYNAMIC_TEMPERATURE_MEASURE_WITH_UNIT']) = 2) AND (
    it.name = 'maximum temperature')) )) <= 1) )) = 1)) )) = 0));
wr12: ((NOT (SELF\shape_aspect.of_shape\property_definition.
    definition\product_definition.frame_of_reference\
    application_context_element.name IN [
    'functional definition','functional occurrence']))) OR (
    SIZEOF(QUERY ( pdr < * USEDIN(SELF,
    'PLANT_SPATIAL_CONFIGURATION.' +
    'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION' ) | (
    'PLANT_SPATIAL_CONFIGURATION.SHAPE_REPRESENTATION' IN
    TYPEOF(pdr.used_representation)) )) = 0));
END_ENTITY; -- hvac_connector

ENTITY hvac_fitting_class
  SUBTYPE OF (group);
  WHERE
    wr1: (SIZEOF(QUERY ( aca < * QUERY ( ca < * USEDIN(SELF,
    'PLANT_SPATIAL_CONFIGURATION.CLASSIFICATION_ASSIGNMENT.' +

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'ASSIGNED_CLASS') |

('PLANT_SPATIAL_CONFIGURATION.APPLIED_CLASSIFICATION_ASSIGNMENT'
  IN TYPEOF(ca)) ) | (NOT (SIZEOF(QUERY ( it < * aca.items | (
  NOT
('PLANT_SPATIAL_CONFIGURATION.HVAC_COMPONENT_DEFINITION'
  IN TYPEOF(it))) )) = 0)) )) = 0);
wr2: (SIZEOF(QUERY ( aca < * QUERY ( ca < * USEDIN(SELF,
'PLANT_SPATIAL_CONFIGURATION.CLASSIFICATION_ASSIGNMENT.' +
'ASSIGNED_CLASS') |

('PLANT_SPATIAL_CONFIGURATION.APPLIED_CLASSIFICATION_ASSIGNMENT'
  IN TYPEOF(ca)) ) | (NOT (SIZEOF(QUERY ( pcd < *
  QUERY ( it < * aca.items | (
  'PLANT_SPATIAL_CONFIGURATION.HVAC_COMPONENT_DEFINITION' IN
  TYPEOF(it)) ) | (NOT (SIZEOF(QUERY ( aca1 < * USEDIN(pcd.
  formation.of_product,'PLANT_SPATIAL_CONFIGURATION.' +
  'APPLIED_CLASSIFICATION_ASSIGNMENT.ITEMS') | class_in_tree(
  aca1.assigned_class,'hvac fitting') )) = 1)) )) = 0)) )) = 0);
END_ENTITY; -- hvac_fitting_class

ENTITY hvac_plant_item_branch_connection
  SUBTYPE OF (shape_aspect_relationship);
  WHERE
    wr1: (SELF.description = 'branch location');
    wr2:
('PLANT_SPATIAL_CONFIGURATION.HVAC_SECTION_SEGMENT_DEFINITION'
  IN TYPEOF(SELF.relate_shape_aspect.of_shape.definition));
    wr3: ('PLANT_SPATIAL_CONFIGURATION.HVAC_CONNECTOR' IN TYPEOF(SELF.
    relate_shape_aspect));
END_ENTITY; -- hvac_plant_item_branch_connection

ENTITY hvac_plant_item_connection
  SUBTYPE OF (shape_aspect_relationship);
  WHERE
    wr1:
('PLANT_SPATIAL_CONFIGURATION.HVAC_SECTION_SEGMENT_TERMINATION'
  IN TYPEOF(SELF.relate_shape_aspect));
    wr2: ('PLANT_SPATIAL_CONFIGURATION.HVAC_CONNECTOR' IN TYPEOF(SELF.
    relate_shape_aspect));
    wr3: (SELF\shape_aspect_relationship.relate_shape_aspect.of_shape\
    property_definition.definition\product_definition.
    frame_of_reference\application_context_element.name =
    'physical occurrence');
END_ENTITY; -- hvac_plant_item_connection

ENTITY hvac_cross_section
  SUBTYPE OF (shape_aspect);
END_ENTITY; -- hvac_section

ENTITY hvac_section_segment_definition
  SUBTYPE OF (product_definition);
  WHERE
    wr1: (SIZEOF(QUERY ( pdr < * USEDIN(SELF,
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    'PLANT_SPATIAL_CONFIGURATION.' +

'PRODUCT_DEFINITION_RELATIONSHIP.RELATED_PRODUCT_DEFINITION')
|
('PLANT_SPATIAL_CONFIGURATION.HVAC_SYSTEM_SECTION_DEFINITION'
  IN TYPEOF(pdr.relateing_product_definition)) )) >= 1);
wr2 : (SIZEOF(QUERY ( pd < * USEDIN(SELf,
  'PLANT_SPATIAL_CONFIGURATION.PROPERTY_DEFINITION.DEFINITION'
  | ('PLANT_SPATIAL_CONFIGURATION.SHAPE_DEFINITION' IN
    TYPEOF(pd)) )) >= 1);
wr3 : (SELF.frame_of_reference\application_context_element.name =
  'functional definition');
wr4 : (SIZEOF(QUERY ( pdr < * USEDIN(SELf,
  'PLANT_SPATIAL_CONFIGURATION.' +
  'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') | (pdr.
  used_representation.name =
  'hvac section segment characteristics') )) = 1);
wr5 : (SIZEOF(QUERY ( hssc < * QUERY ( pdr < * USEDIN(SELf,
  'PLANT_SPATIAL_CONFIGURATION.' +
  'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') | (pdr.
  used_representation.name =
  'hvac section segment characteristics') ) | (NOT ((1 <=
  SIZEOF(QUERY ( it < * hssc.used_representation.items | (it.
  name IN ['pressure drop','maximum pressure drop',
  'minimum pressure drop ']) ))) AND (SIZEOF(QUERY ( it < *
  hssc.used_representation.items | (it.name IN [
  'pressure drop','maximum pressure drop',
  'minimum pressure drop ']) )) <= 2))) )) = 0);
wr6 : (SIZEOF(QUERY ( hssc < * QUERY ( pdr < * USEDIN(SELf,
  'PLANT_SPATIAL_CONFIGURATION.' +
  'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') | (pdr.
  used_representation.name =
  'hvac section segment characteristics') ) | (NOT (SIZEOF(
  QUERY ( it < * hssc.used_representation.items | ((
  'PLANT_SPATIAL_CONFIGURATION.MEASURE_REPRESENTATION_ITEM'
  IN TYPEOF(it)) AND (it.name = 'pressure drop')) )) <= 1)) ))
  = 0);
wr7 : (SIZEOF(QUERY ( hssc < * QUERY ( pdr < * USEDIN(SELf,
  'PLANT_SPATIAL_CONFIGURATION.' +
  'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') | (pdr.
  used_representation.name =
  'hvac section segment characteristics') ) | (NOT (SIZEOF(
  QUERY ( it < * hssc.used_representation.items | ((
  'PLANT_SPATIAL_CONFIGURATION.MEASURE_REPRESENTATION_ITEM'
  IN TYPEOF(it)) AND (it.name = 'minimum pressure drop')) ))
  <= 1)) )) = 0);
wr8 : (SIZEOF(QUERY ( hssc < * QUERY ( pdr < * USEDIN(SELf,
  'PLANT_SPATIAL_CONFIGURATION.' +
  'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') | (pdr.
  used_representation.name =
  'hvac section segment characteristics') ) | (NOT (SIZEOF(

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    QUERY ( it < * hssc.used_representation.items | ((
    'PLANT_SPATIAL_CONFIGURATION.MEASURE_REPRESENTATION_ITEM'
    IN TYPEOF(it)) AND (it.name = 'maximum pressure drop')) ))
    <= 1)) )) = 0);
wr9 : ((NOT (SIZEOF(QUERY ( pdr < * USEDIN(SELF,
    'PLANT_SPATIAL_CONFIGURATION.' +
    'PRODUCT_DEFINITION_RELATIONSHIP.RELATED_PRODUCT_DEFINITION')
    | (pdr.name = 'hvac segment insulation') )) >= 1)) OR (
    SIZEOF(QUERY ( si < * QUERY ( pdr < * USEDIN(SELF,
    'PLANT_SPATIAL_CONFIGURATION.' +
    'PRODUCT_DEFINITION_RELATIONSHIP.RELATED_PRODUCT_DEFINITION')
    | (pdr.name = 'hvac segment insulation') ) | (NOT (SIZEOF(
    QUERY ( pd < * USEDIN(si,
    'PLANT_SPATIAL_CONFIGURATION.PROPERTY_DEFINITION.DEFINITION')
    | (NOT (SIZEOF(QUERY ( pds < * QUERY ( pdr < * USEDIN(pd,
    'PLANT_SPATIAL_CONFIGURATION.' +
    'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') | (
    'PLANT_SPATIAL_CONFIGURATION.PRODUCT_DEFINITION_SHAPE' IN
    TYPEOF(pdr)) ) | (pds.used_representation.name =
    'hvac segment insulation characteristics') )) = 1)) )) = 0)) ))
    = 0));
wr10: ((NOT (SIZEOF(QUERY ( pdr < * USEDIN(SELF,
    'PLANT_SPATIAL_CONFIGURATION.' +
    'PRODUCT_DEFINITION_RELATIONSHIP.RELATED_PRODUCT_DEFINITION')
    | (pdr.name = 'hvac segment insulation') )) >= 1)) OR (
    SIZEOF(QUERY ( si < * QUERY ( pdr < * USEDIN(SELF,
    'PLANT_SPATIAL_CONFIGURATION.' +
    'PRODUCT_DEFINITION_RELATIONSHIP.RELATED_PRODUCT_DEFINITION')
    | (pdr.name = 'hvac segment insulation') ) | (NOT (SIZEOF(
    QUERY ( pd < * USEDIN(si,
    'PLANT_SPATIAL_CONFIGURATION.PROPERTY_DEFINITION.DEFINITION')
    | (NOT (SIZEOF(QUERY ( sic < * QUERY ( pds < *
    QUERY ( pdr < * USEDIN(pd,'PLANT_SPATIAL_CONFIGURATION.' +
    'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') | (
    'PLANT_SPATIAL_CONFIGURATION.PRODUCT_DEFINITION_SHAPE' IN
    TYPEOF(pdr)) ) | (pds.used_representation.name =
    'hvac segment insulation characteristics') ) | (SIZEOF(sic.
    used_representation.items) >= 1) )) = 1)) )) = 0)) )) = 0));
wr11: ((NOT (SIZEOF(QUERY ( pdr < * USEDIN(SELF,
    'PLANT_SPATIAL_CONFIGURATION.' +
    'PRODUCT_DEFINITION_RELATIONSHIP.RELATED_PRODUCT_DEFINITION')
    | (pdr.name = 'hvac segment insulation') )) >= 1)) OR (
    SIZEOF(QUERY ( si < * QUERY ( pdr < * USEDIN(SELF,
    'PLANT_SPATIAL_CONFIGURATION.' +
    'PRODUCT_DEFINITION_RELATIONSHIP.RELATED_PRODUCT_DEFINITION')
    | (pdr.name = 'hvac segment insulation') ) | (NOT (SIZEOF(
    QUERY ( pd < * USEDIN(si,
    'PLANT_SPATIAL_CONFIGURATION.PROPERTY_DEFINITION.DEFINITION')

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| (NOT (SIZEOF(QUERY ( sic <* QUERY ( pds <*
QUERY ( pdr <* USEDIN(pd,'PLANT_SPATIAL_CONFIGURATION.' +
'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') | (
'PLANT_SPATIAL_CONFIGURATION.PRODUCT_DEFINITION_SHAPE' IN
TYPEOF(pdr)) ) | (pds.used_representation.name =
'hvac segment insulation characteristics') ) | ((1 <=
SIZEOF(QUERY ( it <* sic.used_representation.items | ((
SIZEOF(TYPEOF(it) * [
'PLANT_SPATIAL_CONFIGURATION.MEASURE_REPRESENTATION_ITEM',
'PLANT_SPATIAL_CONFIGURATION.LENGTH_MEASURE_WITH_UNIT']) =
2) AND (it.name IN ['thickness','minimum thickness',
'maximum thickness'])) ))) AND (SIZEOF(QUERY ( it <* sic.
used_representation.items | ((SIZEOF(TYPEOF(it) * [
'PLANT_SPATIAL_CONFIGURATION.MEASURE_REPRESENTATION_ITEM',
'PLANT_SPATIAL_CONFIGURATION.LENGTH_MEASURE_WITH_UNIT']) =
2) AND (it.name IN ['thickness','minimum thickness',
'maximum thickness'])) ) ) <= 2)) ) = 1)) ) = 0)) ) = 0));
wr12: ((NOT (SIZEOF(QUERY ( pdr <* USEDIN(SELF,
'PLANT_SPATIAL_CONFIGURATION.' +
'PRODUCT_DEFINITION_RELATIONSHIP.RELATED_PRODUCT_DEFINITION')
| (pdr.name = 'hvac segment insulation') ) ) >= 1)) OR (
SIZEOF(QUERY ( si <* QUERY ( pdr <* USEDIN(SELF,
'PLANT_SPATIAL_CONFIGURATION.' +
'PRODUCT_DEFINITION_RELATIONSHIP.RELATED_PRODUCT_DEFINITION')
| (pdr.name = 'hvac segment insulation') ) | (NOT (SIZEOF(
QUERY ( pd <* USEDIN(si,
'PLANT_SPATIAL_CONFIGURATION.PROPERTY_DEFINITION.DEFINITION')
| (NOT (SIZEOF(QUERY ( sic <* QUERY ( pds <*
QUERY ( pdr <* USEDIN(pd,'PLANT_SPATIAL_CONFIGURATION.' +
'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') | (
'PLANT_SPATIAL_CONFIGURATION.PRODUCT_DEFINITION_SHAPE' IN
TYPEOF(pdr)) ) | (pds.used_representation.name =
'segment insulation characteristics') ) | (SIZEOF(
QUERY ( it <* sic.used_representation.items | ((SIZEOF(
TYPEOF(it) * [
'PLANT_SPATIAL_CONFIGURATION.MEASURE_REPRESENTATION_ITEM',
'PLANT_SPATIAL_CONFIGURATION.LENGTH_MEASURE_WITH_UNIT']) =
2) AND (it.name = 'thickness')) ) ) <= 1)) ) = 1)) ) = 0)) ) =
0));
wr13: ((NOT (SIZEOF(QUERY ( pdr <* USEDIN(SELF,
'PLANT_SPATIAL_CONFIGURATION.' +
'PRODUCT_DEFINITION_RELATIONSHIP.RELATED_PRODUCT_DEFINITION')
| (pdr.name = 'segment insulation') ) ) >= 1)) OR (SIZEOF(
QUERY ( si <* QUERY ( pdr <* USEDIN(SELF,
'PLANT_SPATIAL_CONFIGURATION.' +
'PRODUCT_DEFINITION_RELATIONSHIP.RELATED_PRODUCT_DEFINITION')
| (pdr.name = 'hvac segment insulation') ) | (NOT (SIZEOF(

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QUERY ( pd <* USEDIN(si,
'PLANT_SPATIAL_CONFIGURATION.PROPERTY_DEFINITION.DEFINITION')
| (NOT (SIZEOF(QUERY ( sic <* QUERY ( pds <*
QUERY ( pdr <* USEDIN(pd,'PLANT_SPATIAL_CONFIGURATION.' +
'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') | (
'PLANT_SPATIAL_CONFIGURATION.PRODUCT_DEFINITION_SHAPE' IN
TYPEOF(pdr)) ) | (pds.used_representation.name =
'hvac segment insulation characteristics') ) | (SIZEOF(
QUERY ( it <* sic.used_representation.items | ((SIZEOF(
TYPEOF(it) * [
'PLANT_SPATIAL_CONFIGURATION.MEASURE_REPRESENTATION_ITEM',
'PLANT_SPATIAL_CONFIGURATION.LENGTH_MEASURE_WITH_UNIT']) =
2) AND (it.name = 'minimum thickness')) ) <= 1) ) = 1)) ) =
0)) ) = 0));
wr14: ((NOT (SIZEOF(QUERY ( pdr <* USEDIN(SELF,
'PLANT_SPATIAL_CONFIGURATION.' +
'PRODUCT_DEFINITION_RELATIONSHIP.RELATED_PRODUCT_DEFINITION')
| (pdr.name = 'hvac segment insulation') ) >= 1)) OR (
SIZEOF(QUERY ( si <* QUERY ( pdr <* USEDIN(SELF,
'PLANT_SPATIAL_CONFIGURATION.' +
'PRODUCT_DEFINITION_RELATIONSHIP.RELATED_PRODUCT_DEFINITION')
| (pdr.name = 'hvac segment insulation') ) | (NOT (SIZEOF(
QUERY ( pd <* USEDIN(si,
'PLANT_SPATIAL_CONFIGURATION.PROPERTY_DEFINITION.DEFINITION')
| (NOT (SIZEOF(QUERY ( sic <* QUERY ( pds <*
QUERY ( pdr <* USEDIN(pd,'PLANT_SPATIAL_CONFIGURATION.' +
'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') | (
'PLANT_SPATIAL_CONFIGURATION.PRODUCT_DEFINITION_SHAPE' IN
TYPEOF(pdr)) ) | (pds.used_representation.name =
'hvac segment insulation characteristics') ) | (SIZEOF(
QUERY ( it <* sic.used_representation.items | ((SIZEOF(
TYPEOF(it) * [
'PLANT_SPATIAL_CONFIGURATION.MEASURE_REPRESENTATION_ITEM',
'PLANT_SPATIAL_CONFIGURATION.LENGTH_MEASURE_WITH_UNIT']) =
2) AND (it.name = 'maximum thickness')) ) <= 1) ) = 1)) ) =
0)) ) = 0));
wr15: (SIZEOF(QUERY ( pds <* QUERY ( pd <* USEDIN(SELF,
'PLANT_SPATIAL_CONFIGURATION.PROPERTY_DEFINITION.DEFINITION')
| ('PLANT_SPATIAL_CONFIGURATION.PRODUCT_DEFINITION_SHAPE'
IN TYPEOF(pd)) ) | (NOT (SIZEOF(QUERY ( sa <* USEDIN(pds,
'PLANT_SPATIAL_CONFIGURATION.SHAPE_ASPECT.OF_SHAPE') |
('PLANT_SPATIAL_CONFIGURATION.HVAC_SECTION_SEGMENT_TERMINATION'
IN TYPEOF(sa)) ) = 2)) ) = 0);
END_ENTITY; -- hvac_section_segment_definition

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ENTITY hvac\_section\_segment\_termination

SUBTYPE OF (shape\_aspect);

WHERE

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wr1: (SIZEOF(QUERY ( sar <* (USEDIN(SELF,
'PLANT_SPATIAL_CONFIGURATION.' +
'SHAPE_ASPECT_RELATIONSHIP.RELATING_SHAPE_ASPECT') + USEDIN(

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        SELF,'PLANT_SPATIAL_CONFIGURATION.' +
        'SHAPE_ASPECT_RELATIONSHIP.RELATED_SHAPE_ASPECT')) | (NOT (
        SIZEOF(TYPEOF(sar) * [
        'PLANT_SPATIAL_CONFIGURATION.HVAC_BRANCH_CONNECTION',
        'PLANT_SPATIAL_CONFIGURATION.HVAC_PLANT_ITEM_CONNECTION',
        'PLANT_SPATIAL_CONFIGURATION.HVAC_TERMINATION_CONNECTION'])
        = 1)) )) = 0);
wr2: (SIZEOF(QUERY ( sar <* USEDIN(SELF,
        'PLANT_SPATIAL_CONFIGURATION.' +
        'SHAPE_ASPECT_RELATIONSHIP.RELATED_SHAPE_ASPECT')) | (SIZEOF(
        TYPEOF(sar) * [
        'PLANT_SPATIAL_CONFIGURATION.HVAC_BRANCH_CONNECTION',
        'PLANT_SPATIAL_CONFIGURATION.HVAC_PLANT_ITEM_CONNECTION']) =
        1)) )) = 1);
END_ENTITY; -- hvac_section_segment_termination

ENTITY hvac_system
SUBTYPE OF (product_definition);
WHERE
    wr1: (SIZEOF(QUERY ( pdr <* USEDIN(SELF,
        'PLANT_SPATIAL_CONFIGURATION.' +
        'PRODUCT_DEFINITION_RELATIONSHIP.RELATED_PRODUCT_DEFINITION')
        | (('PLANT_SPATIAL_CONFIGURATION.PLANT' IN TYPEOF(pdr.
        relating_product_definition.formation.of_product)) AND (pdr.
        relating_product_definition.frame_of_reference.name =
        'functional occurrence')) )) = 1);
END_ENTITY; -- hvac_system

ENTITY hvac_system_section_definition
SUBTYPE OF (product_definition);
WHERE
    wr1: (SIZEOF(QUERY ( pdr <* USEDIN(SELF,
        'PLANT_SPATIAL_CONFIGURATION.' +
        'PRODUCT_DEFINITION_RELATIONSHIP.RELATED_PRODUCT_DEFINITION')
        | ('PLANT_SPATIAL_CONFIGURATION.HVAC_SYSTEM' IN TYPEOF(pdr.
        relating_product_definition)) )) = 1);
    wr2: (SIZEOF(QUERY ( pdr <* USEDIN(SELF,
        'PLANT_SPATIAL_CONFIGURATION.' +
        'PRODUCT_DEFINITION_RELATIONSHIP.RELATING_PRODUCT_DEFINITION')
        |
        ('PLANT_SPATIAL_CONFIGURATION.HVAC_SECTION_SEGMENT_DEFINITION'
        IN TYPEOF(pdr.related_product_definition)) )) >= 1);
    wr3: (SELF.frame_of_reference.name = 'functional definition');
    wr4: (SIZEOF(QUERY ( pds <* QUERY ( pd <* USEDIN(SELF,
        'PLANT_SPATIAL_CONFIGURATION.PROPERTY_DEFINITION.DEFINITION')
        | ('PLANT_SPATIAL_CONFIGURATION.PRODUCT_DEFINITION_SHAPE'
        IN TYPEOF(pd)) )) | (NOT (SIZEOF(QUERY ( sa <* USEDIN(pds,
        'PLANT_SPATIAL_CONFIGURATION.SHAPE_ASPECT.OF_SHAPE') |
        (('PLANT_SPATIAL_CONFIGURATION.HVAC_SECTION_SEGMENT_TERMINATION'

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    IN TYPEOF(sa)) AND (sa.description =
    'hvac system section termination')) )) <= 2)) )) = 0);
END_ENTITY; -- hvac_system_section_definition

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ENTITY hvac_termination_connection
  SUBTYPE OF (shape_aspect_relationship);
  WHERE
    wr1:
    ('PLANT_SPATIAL_CONFIGURATION.HVAC_SECTION_SEGMENT_TERMINATION'
     IN TYPEOF(SELF.relate_shape_aspect));
    wr2:
    ('PLANT_SPATIAL_CONFIGURATION.HVAC_SECTION_SEGMENT_TERMINATION'
     IN TYPEOF(SELF.related_shape_aspect));
END_ENTITY; -- hvac_termination_connection

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ENTITY hybrid_shape_representation
  SUBTYPE OF (shape_representation);
  WHERE
    wr1: (SIZEOF(QUERY ( i < * SELF\representation.items | (NOT (SIZEOF([
    'PLANT_SPATIAL_CONFIGURATION.BOOLEAN_RESULT',
    'PLANT_SPATIAL_CONFIGURATION.CSG_SOLID',
    'PLANT_SPATIAL_CONFIGURATION.RECTANGULAR_PYRAMID',
    'PLANT_SPATIAL_CONFIGURATION.BLOCK',
    'PLANT_SPATIAL_CONFIGURATION.TORUS',
    'PLANT_SPATIAL_CONFIGURATION.RIGHT_CIRCULAR_CYLINDER',
    'PLANT_SPATIAL_CONFIGURATION.SPHERE',
    'PLANT_SPATIAL_CONFIGURATION.RIGHT_CIRCULAR_CONE',
    'PLANT_SPATIAL_CONFIGURATION.EXTRUDED_AREA_SOLID',
    'PLANT_SPATIAL_CONFIGURATION.REVOLVED_AREA_SOLID',
    'PLANT_SPATIAL_CONFIGURATION.AXIS2_PLACEMENT_3D',
    'PLANT_SPATIAL_CONFIGURATION.MANIFOLD_SOLID_BREP',
    'PLANT_SPATIAL_CONFIGURATION.SHELL_BASED_WIREFRAME_MODEL',
    'PLANT_SPATIAL_CONFIGURATION.CURVE',
    'PLANT_SPATIAL_CONFIGURATION.POINT',
    'PLANT_SPATIAL_CONFIGURATION.SURFACE',
    'PLANT_SPATIAL_CONFIGURATION.VECTOR',
    'PLANT_SPATIAL_CONFIGURATION.MEASURE_REPRESENTATION_ITEM',
    'PLANT_SPATIAL_CONFIGURATION.MAPPED_ITEM'] * TYPEOF(i)) = 1)) ))
    = 0);
    wr2: (SIZEOF(QUERY ( mi < * QUERY ( item < * SELF\representation.items
    | ('PLANT_SPATIAL_CONFIGURATION.MAPPED_ITEM' IN TYPEOF(item)) )
    | (NOT (SIZEOF(['PLANT_SPATIAL_CONFIGURATION.' +
    'PLANT_CSG_SHAPE_REPRESENTATION',
    'PLANT_SPATIAL_CONFIGURATION.HYBRID_SHAPE_REPRESENTATION'] *
    TYPEOF(mi\mapped_item.mapping_source.mapped_representation))
    = 1)) )) = 0);
END_ENTITY; -- hybrid_shape_representation

```

```

ENTITY hyperbola
  SUBTYPE OF (conic);
  semi_axis      : positive_length_measure;
  semi_imag_axis : positive_length_measure;
END_ENTITY; -- hyperbola

```

```
ENTITY id_attribute;
    attribute_value : identifier;
    identified_item : id_attribute_select;
END_ENTITY; -- id_attribute
```

```
ENTITY identification_assignment
    ABSTRACT SUPERTYPE;
    assigned_id : identifier;
    role : identification_role;
END_ENTITY; -- identification_assignment
```

```
ENTITY identification_role;
    name : label;
    description : OPTIONAL text;
END_ENTITY; -- identification_role
```

```
ENTITY inline_equipment
    SUBTYPE OF (piping_component_definition);
END_ENTITY; -- inline_equipment
```

```
ENTITY instrumentation_and_control_system
    SUBTYPE OF (product_definition);
    WHERE
        wr1: (SIZEOF(QUERY ( pdr <= USEDIN(SELF,
            'PLANT_SPATIAL_CONFIGURATION.' +
            'PRODUCT_DEFINITION_RELATIONSHIP.RELATED_PRODUCT_DEFINITION')
            | (('PLANT_SPATIAL_CONFIGURATION.PLANT' IN TYPEOF(pdr.
            relating_product_definition.formation.of_product)) AND (pdr.
            relating_product_definition.frame_of_reference.name =
            'functional occurrence')) )) = 1);
END_ENTITY; -- instrumentation_and_control_system
```

```
ENTITY interfering_shape_element
    SUBTYPE OF (shape_aspect, shape_aspect_relationship);
END_ENTITY; -- interfering_shape_element
```

```
ENTITY intersection_curve
    SUBTYPE OF (surface_curve);
    WHERE
        wr1: (SIZEOF(SELF\surface_curve.associated_geometry) = 2);
        wr2: (associated_surface(SELF\surface_curve.associated_geometry[1])
            <> associated_surface(SELF\surface_curve.associated_geometry
            [2]));
END_ENTITY; -- intersection_curve
```

```
ENTITY item_identified_representation_usage;
    name : label;
    description : OPTIONAL text;
    definition : represented_definition;
    used_representation : representation;
    identified_item : representation_item;
```

WHERE

WR1: SELF.used\_representation IN  
using\_representations(SELF.identified\_item);  
END\_ENTITY; -- item\_identified\_representation\_usage

ENTITY known\_source

SUBTYPE OF (external\_source, pre\_defined\_item);  
WHERE  
wr1: (SELF\pre\_defined\_item.name IN ['ISO 13584 Dictionary',  
'ISO 13584 Parts Library']);  
END\_ENTITY; -- known\_source

ENTITY length\_measure\_with\_unit

SUBTYPE OF (measure\_with\_unit);  
WHERE  
wr1: ('PLANT\_SPATIAL\_CONFIGURATION.LENGTH\_UNIT' IN  
TYPEOF(SELF\measure\_with\_unit.unit\_component));  
END\_ENTITY; -- length\_measure\_with\_unit

ENTITY length\_unit

SUBTYPE OF (named\_unit);  
WHERE  
wr1: ((SELF\named\_unit.dimensions.length\_exponent = 1) AND (SELF\  
named\_unit.dimensions.mass\_exponent = 0) AND (SELF\  
named\_unit.dimensions.time\_exponent = 0) AND (SELF\  
named\_unit.dimensions.electric\_current\_exponent = 0) AND (  
SELF\named\_unit.dimensions.  
thermodynamic\_temperature\_exponent = 0) AND (SELF\named\_unit  
.dimensions.amount\_of\_substance\_exponent = 0) AND (SELF\  
named\_unit.dimensions.luminous\_intensity\_exponent = 0));  
END\_ENTITY; -- length\_unit

ENTITY line

SUBTYPE OF (curve);  
pnt : cartesian\_point;  
dir : vector;  
WHERE  
wr1: (dir.dim = pnt.dim);  
END\_ENTITY; -- line

ENTITY line\_branch\_connection

SUBTYPE OF (shape\_aspect\_relationship);  
WHERE  
wr1: (SELF.description = 'branch location');  
wr2: ('PLANT\_SPATIAL\_CONFIGURATION.PLANT\_LINE\_SEGMENT\_DEFINITION'  
IN  
TYPEOF(SELF.relate\_shape\_aspect.of\_shape.definition));  
wr3:  
( 'PLANT\_SPATIAL\_CONFIGURATION.PLANT\_LINE\_SEGMENT\_TERMINATION'  
IN TYPEOF(SELF.related\_shape\_aspect));  
END\_ENTITY; -- line\_branch\_connection

ENTITY line\_less\_piping\_system

SUBTYPE OF (product\_definition);  
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```

END_ENTITY; -- line_less_piping_system

ENTITY line_plant_item_branch_connection
  SUBTYPE OF (shape_aspect_relationship);
END_ENTITY; -- line_plant_item_branch_connection

ENTITY line_plant_item_connection
  SUBTYPE OF (shape_aspect_relationship);
  WHERE
    wr1:
      ('PLANT_SPATIAL_CONFIGURATION.PLANT_LINE_SEGMENT_TERMINATION'
        IN TYPEOF(SELF.relate_shape_aspect));
    wr2: ('PLANT_SPATIAL_CONFIGURATION.PLANT_ITEM_CONNECTOR' IN
      TYPEOF(
        SELF.relate_shape_aspect));
    wr3: (SELF\shape_aspect_relationship.relate_shape_aspect.of_shape\
      property_definition.definition\product_definition.
        frame_of_reference\application_context_element.name =
        'physical occurrence');
END_ENTITY; -- line_plant_item_connection

ENTITY line_termination_connection
  SUBTYPE OF (shape_aspect_relationship);
  WHERE
    wr1: (SIZEOF(TYPEOF(SELF.relate_shape_aspect) *
      ['PLANT_SPATIAL_CONFIGURATION.CONNECTION_NODE',
        'PLANT_SPATIAL_CONFIGURATION.PLANT_LINE_SEGMENT_TERMINATION'])
      >= 1);
    wr2:
      ('PLANT_SPATIAL_CONFIGURATION.PLANT_LINE_SEGMENT_TERMINATION'
        IN TYPEOF(SELF.relate_shape_aspect));
END_ENTITY; -- line_termination_connection

ENTITY local_time;
  hour_component : hour_in_day;
  minute_component : OPTIONAL minute_in_hour;
  second_component : OPTIONAL second_in_minute;
  zone : coordinated_universal_time_offset;
  WHERE
    wr1: valid_time(SELF);
END_ENTITY; -- local_time

ENTITY loop
  SUPERTYPE OF (ONEOF (vertex_loop,edge_loop,poly_loop))
  SUBTYPE OF (topological_representation_item);
END_ENTITY; -- loop

ENTITY luminous_intensity_measure_with_unit
  SUBTYPE OF (measure_with_unit);
  WHERE
    wr1: ('PLANT_SPATIAL_CONFIGURATION.LUMINOUS_INTENSITY_UNIT' IN

```

```

        TYPEOF(SELF\measure_with_unit.unit_component));
END_ENTITY; -- luminous_intensity_measure_with_unit

```

```

ENTITY luminous_intensity_unit
  SUBTYPE OF (named_unit);
  WHERE
    wr1: ((SELF\named_unit.dimensions.length_exponent = 0) AND (SELF\
      named_unit.dimensions.mass_exponent = 0) AND (SELF\
      named_unit.dimensions.time_exponent = 0) AND (SELF\
      named_unit.dimensions.electric_current_exponent = 0) AND (
      SELF\named_unit.dimensions.
      thermodynamic_temperature_exponent = 0) AND (SELF\named_unit
      .dimensions.amount_of_substance_exponent = 0) AND (SELF\
      named_unit.dimensions.luminous_intensity_exponent = 1));
END_ENTITY; -- luminous_intensity_unit

```

```

ENTITY make_from_usage_option
  SUBTYPE OF (product_definition_usage);
  ranking      : INTEGER;
  ranking_rationale : text;
  quantity      : measure_with_unit;
  WHERE
    wr1: ((NOT ('NUMBER' IN TYPEOF(quantity.value_component))) OR (
      quantity.value_component > 0));
END_ENTITY; -- make_from_usage_option

```

```

ENTITY manifold_solid_brep
  SUBTYPE OF (solid_model);
  outer : closed_shell;
END_ENTITY; -- manifold_solid_brep

```

```

ENTITY mapped_item
  SUBTYPE OF (representation_item);
  mapping_source : representation_map;
  mapping_target : representation_item;
  WHERE
    wr1: acyclic_mapped_representation(using_representations(SELF),[SELF]);
END_ENTITY; -- mapped_item

```

```

ENTITY mass_measure_with_unit
  SUBTYPE OF (measure_with_unit);
  WHERE
    wr1: ('PLANT_SPATIAL_CONFIGURATION.MASS_UNIT' IN
      TYPEOF(SELF\measure_with_unit.unit_component));
END_ENTITY; -- mass_measure_with_unit

```

```

ENTITY mass_unit
  SUBTYPE OF (named_unit);
  WHERE
    wr1: ((SELF\named_unit.dimensions.length_exponent = 0) AND (SELF\
      named_unit.dimensions.mass_exponent = 1) AND (SELF\
      named_unit.dimensions.time_exponent = 0) AND (SELF\
      named_unit.dimensions.electric_current_exponent = 0) AND (
      SELF\named_unit.dimensions.

```

```

        thermodynamic_temperature_exponent = 0) AND (SELF\named_unit
        .dimensions.amount_of_substance_exponent = 0) AND (SELF\
        named_unit.dimensions.luminous_intensity_exponent = 0));
END_ENTITY; -- mass_unit

```

```

ENTITY material_designation;
    name      : label;
    definitions : SET [1:?] OF characterized_definition;
END_ENTITY; -- material_designation

```

```

ENTITY material_designation_characterization;
    name      : label;
    description : text;
    designation : material_designation;
    property   : characterized_material_property;
END_ENTITY; -- material_designation_characterization

```

```

ENTITY material_property
    SUBTYPE OF (property_definition);
    WHERE
        wr1: ((('PLANT_SPATIAL_CONFIGURATION.CHARACTERIZED_OBJECT' IN
        TYPEOF(SELF\property_definition.definition)) OR (SIZEOF(
        bag_to_set(USEDIN(SELF,
        'PLANT_SPATIAL_CONFIGURATION.' +
        'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION')) -
        QUERY ( temp < * bag_to_set(USEDIN(SELF,
        'PLANT_SPATIAL_CONFIGURATION.' +
        'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION')) | ((
        'PLANT_SPATIAL_CONFIGURATION.' +
        'MATERIAL_PROPERTY_REPRESENTATION') IN TYPEOF(temp)) )) = 0));
END_ENTITY; -- material_property

```

```

ENTITY material_property_representation
    SUBTYPE OF (property_definition_representation);
    dependent_environment : data_environment;
END_ENTITY; -- material_property_representation

```

```

ENTITY measure_representation_item
    SUBTYPE OF (representation_item, measure_with_unit);
END_ENTITY; -- measure_representation_item

```

```

ENTITY measure_with_unit
    SUPERTYPE OF (ONEOF (length_measure_with_unit, mass_measure_with_unit,
    time_measure_with_unit, electric_current_measure_with_unit,
    thermodynamic_temperature_measure_with_unit,
    amount_of_substance_measure_with_unit,
    luminous_intensity_measure_with_unit, plane_angle_measure_with_unit,
    solid_angle_measure_with_unit, ratio_measure_with_unit));
    value_component : measure_value;
    unit_component  : unit;
    WHERE

```

```

    wr1: valid_units(SELF);
END_ENTITY; -- measure_with_unit

```

```

ENTITY name_assignment
  ABSTRACT SUPERTYPE;
  assigned_name : label;
  DERIVE
    role : object_role := get_role(SELF);
  WHERE
    wr1: (SIZEOF(USEDIN(SELF,'PLANT_SPATIAL_CONFIGURATION.' +
      'ROLE_ASSOCIATION.ITEM_WITH_ROLE')) <= 1);
END_ENTITY; -- name_assignment

```

```

ENTITY name_attribute;
  attribute_value : label;
  named_item      : name_attribute_select;
END_ENTITY; -- name_attribute

```

```

ENTITY named_unit
  SUPERTYPE OF (ONEOF (si_unit,conversion_based_unit,
    context_dependent_unit) ANDOR ONEOF (length_unit,mass_unit,
    time_unit,electric_current_unit,thermodynamic_temperature_unit,
    amount_of_substance_unit,luminous_intensity_unit,plane_angle_unit,
    solid_angle_unit,ratio_unit));
  dimensions : dimensional_exponents;
END_ENTITY; -- named_unit

```

```

ENTITY object_role;
  name      : label;
  description : OPTIONAL text;
END_ENTITY; -- object_role

```

```

ENTITY offset_curve_2d
  SUBTYPE OF (curve);
  basis_curve : curve;
  distance     : length_measure;
  self_intersect : LOGICAL;
  WHERE
    wr1: (basis_curve.dim = 2);
END_ENTITY; -- offset_curve_2d

```

```

ENTITY offset_curve_3d
  SUBTYPE OF (curve);
  basis_curve : curve;
  distance     : length_measure;
  self_intersect : LOGICAL;
  ref_direction : direction;
  WHERE
    wr1: ((basis_curve.dim = 3) AND (ref_direction.dim = 3));
END_ENTITY; -- offset_curve_3d

```

```

ENTITY offset_surface
  SUBTYPE OF (surface);
  basis_surface : surface;
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```

```

    distance      : length_measure;
    self_intersect : LOGICAL;
END_ENTITY; -- offset_surface

```

```

ENTITY open_shell
  SUBTYPE OF (connected_face_set);
END_ENTITY; -- open_shell

```

```

ENTITY organization;
  id      : OPTIONAL identifier;
  name    : label;
  description : OPTIONAL text;
END_ENTITY; -- organization

```

```

ENTITY organization_assignment
  ABSTRACT SUPERTYPE;
  assigned_organization : organization;
  role                  : organization_role;
END_ENTITY; -- organization_assignment

```

```

ENTITY organization_role;
  name : label;
  DERIVE
    description : text := get_description_value(SELf);
  WHERE
    wr1: (SIZEOF(USEDIN(SELf,'PLANT_SPATIAL_CONFIGURATION.' +
      'DESCRIPTION_ATTRIBUTE.DESCRIBED_ITEM')) <= 1);
END_ENTITY; -- organization_role

```

```

ENTITY organizational_project;
  name      : label;
  description : OPTIONAL text;
  responsible_organizations : SET [1:?] OF organization;
  DERIVE
    id : identifier := get_id_value(SELf);
  WHERE
    wr1: (SIZEOF(USEDIN(SELf,'PLANT_SPATIAL_CONFIGURATION.' +
      'ID_ATTRIBUTE.IDENTIFIED_ITEM')) <= 1);
END_ENTITY; -- organizational_project

```

```

ENTITY oriented_closed_shell
  SUBTYPE OF (closed_shell);
  closed_shell_element : closed_shell;
  orientation           : BOOLEAN;
  DERIVE
    SELf\connected_face_set.cfs_faces : SET [1:?] OF face :=
      conditional_reverse(SELf.
        orientation,SELf.
        closed_shell_element.cfs_faces);
  WHERE
    wr1: (NOT ('PLANT_SPATIAL_CONFIGURATION.ORIENTED_CLOSED_SHELL' IN

```

```

        TYPEOF(SELF.closed_shell_element)));
END_ENTITY; -- oriented_closed_shell

ENTITY oriented_edge
SUBTYPE OF (edge);
    edge_element : edge;
    orientation   : BOOLEAN;
DERIVE
    SELF\edge.edge_start : vertex := boolean_choose(SELF.orientation,
        SELF.edge_element.edge_start,SELF.
        edge_element.edge_end);
    SELF\edge.edge_end   : vertex := boolean_choose(SELF.orientation,
        SELF.edge_element.edge_end,SELF.
        edge_element.edge_start);
WHERE
    wr1: (NOT ('PLANT_SPATIAL_CONFIGURATION.ORIENTED_EDGE' IN
        TYPEOF(SELF.
            edge_element)));
END_ENTITY; -- oriented_edge

ENTITY oriented_face
SUBTYPE OF (face);
    face_element : face;
    orientation   : BOOLEAN;
DERIVE
    SELF\face.bounds : SET [1:?] OF face_bound := conditional_reverse(
        SELF.orientation,SELF.face_element.bounds);
WHERE
    wr1: (NOT ('PLANT_SPATIAL_CONFIGURATION.ORIENTED_FACE' IN
        TYPEOF(SELF.
            face_element)));
END_ENTITY; -- oriented_face

ENTITY oriented_open_shell
SUBTYPE OF (open_shell);
    open_shell_element : open_shell;
    orientation         : BOOLEAN;
DERIVE
    SELF\connected_face_set.cfs_faces : SET [1:?] OF face :=
        conditional_reverse(SELF.
            orientation,SELF.
            open_shell_element.cfs_faces);
WHERE
    wr1: (NOT ('PLANT_SPATIAL_CONFIGURATION.ORIENTED_OPEN_SHELL' IN
        TYPEOF(SELF.open_shell_element)));
END_ENTITY; -- oriented_open_shell

ENTITY oriented_path
SUBTYPE OF (path);
    path_element : path;
    orientation   : BOOLEAN;
DERIVE
    SELF\path.edge_list : LIST [1:?] OF oriented_edge :=
        conditional_reverse(SELF.orientation,SELF.

```

```

        path_element.edge_list);
    WHERE
        wr1: (NOT ('PLANT_SPATIAL_CONFIGURATION.ORIENTED_PATH' IN
    TYPEOF(SELF.
        path_element)));
    END_ENTITY; -- oriented_path

ENTITY outer_boundary_curve
    SUBTYPE OF (boundary_curve);
    END_ENTITY; -- outer_boundary_curve

ENTITY parabola
    SUBTYPE OF (conic);
    focal_dist : length_measure;
    WHERE
        wr1: (focal_dist <> 0);
    END_ENTITY; -- parabola

ENTITY parametric_representation_context
    SUBTYPE OF (representation_context);
    END_ENTITY; -- parametric_representation_context

ENTITY path
    SUPERTYPE OF (ONEOF (edge_loop,oriented_path))
    SUBTYPE OF (topological_representation_item);
    edge_list : LIST [1:?] OF oriented_edge;
    WHERE
        wr1: path_head_to_tail(SELF);
    END_ENTITY; -- path

ENTITY pcurve
    SUBTYPE OF (curve);
    basis_surface : surface;
    reference_to_curve : definitional_representation;
    WHERE
        wr1: (SIZEOF(reference_to_curve\representation.items) = 1);
        wr2: ('PLANT_SPATIAL_CONFIGURATION.CURVE' IN TYPEOF(reference_to_curve\
            representation.items[1]));
        wr3: (reference_to_curve\representation.items[1]\
            geometric_representation_item.dim = 2);
    END_ENTITY; -- pcurve

ENTITY person;
    id : identifier;
    last_name : OPTIONAL label;
    first_name : OPTIONAL label;
    middle_names : OPTIONAL LIST [1:?] OF label;
    prefix_titles : OPTIONAL LIST [1:?] OF label;
    suffix_titles : OPTIONAL LIST [1:?] OF label;
    WHERE
        wr1: (EXISTS(last_name) OR EXISTS(first_name));

```

END\_ENTITY; -- person

ENTITY person\_and\_organization;

the\_person : person;

the\_organization : organization;

DERIVE

name : label := get\_name\_value(SELF);

description : text := get\_description\_value(SELF);

WHERE

wr1: (SIZEOF(USEDIN(SELF,'PLANT\_SPATIAL\_CONFIGURATION.' +  
'NAME\_ATTRIBUTE.NAMED\_ITEM')) <= 1);

wr2: (SIZEOF(USEDIN(SELF,'PLANT\_SPATIAL\_CONFIGURATION.' +  
'DESCRIPTION\_ATTRIBUTE.DESCRIBED\_ITEM')) <= 1);

END\_ENTITY; -- person\_and\_organization

ENTITY person\_and\_organization\_assignment

ABSTRACT SUPERTYPE;

assigned\_person\_and\_organization : person\_and\_organization;

role : person\_and\_organization\_role;

END\_ENTITY; -- person\_and\_organization\_assignment

ENTITY person\_and\_organization\_role;

name : label;

DERIVE

description : text := get\_description\_value(SELF);

WHERE

wr1: (SIZEOF(USEDIN(SELF,'PLANT\_SPATIAL\_CONFIGURATION.' +  
'DESCRIPTION\_ATTRIBUTE.DESCRIBED\_ITEM')) <= 1);

END\_ENTITY; -- person\_and\_organization\_role

ENTITY person\_assignment

ABSTRACT SUPERTYPE;

assigned\_person : person;

role : person\_role;

END\_ENTITY; -- person\_assignment

ENTITY person\_role;

name : label;

DERIVE

description : text := get\_description\_value(SELF);

WHERE

wr1: (SIZEOF(USEDIN(SELF,'PLANT\_SPATIAL\_CONFIGURATION.' +  
'DESCRIPTION\_ATTRIBUTE.DESCRIBED\_ITEM')) <= 1);

END\_ENTITY; -- person\_role

ENTITY pipe\_class

SUBTYPE OF (group);

WHERE

wr1: (SIZEOF(QUERY ( aca <\* QUERY ( ca <\* USEDIN(SELF,  
'PLANT\_SPATIAL\_CONFIGURATION.CLASSIFICATION\_ASSIGNMENT.' +  
'ASSIGNED\_CLASS') |

('PLANT\_SPATIAL\_CONFIGURATION.APPLIED\_CLASSIFICATION\_ASSIGNMENT'  
IN TYPEOF(ca)) ) | ( NOT (SIZEOF(QUERY ( it <\* aca.items | (

```

NOT (
  'PLANT_SPATIAL_CONFIGURATION.PIPING_COMPONENT_DEFINITION' IN
  TYPEOF(it))) )) = 0)) )) = 0);
wr2: (SIZEOF(QUERY ( aca <* QUERY ( ca <* USEDIN(SELF,
  'PLANT_SPATIAL_CONFIGURATION.CLASSIFICATION_ASSIGNMENT.' +
  'ASSIGNED_CLASS') |

('PLANT_SPATIAL_CONFIGURATION.APPLIED_CLASSIFICATION_ASSIGNMENT'
  IN TYPEOF(ca)) ) | (NOT (SIZEOF(QUERY ( pcd <*
  QUERY ( it <* aca.items | (
  'PLANT_SPATIAL_CONFIGURATION.PIPING_COMPONENT_DEFINITION' IN
  TYPEOF(it))) ) | (NOT (SIZEOF(QUERY ( aca1 <* USEDIN(pcd.
  formation.of_product,'PLANT_SPATIAL_CONFIGURATION.' +
  'APPLIED_CLASSIFICATION_ASSIGNMENT.ITEMS') | class_in_tree(
  aca1.assigned_class,'pipe') )) = 1))) )) = 0))) )) = 0);
END_ENTITY; -- pipe_class

ENTITY pipe_closure_fitting_class
  SUBTYPE OF (group);
  WHERE
    wr1: (SIZEOF(QUERY ( aca <* QUERY ( ca <* USEDIN(SELF,
      'PLANT_SPATIAL_CONFIGURATION.CLASSIFICATION_ASSIGNMENT.' +
      'ASSIGNED_CLASS') |

('PLANT_SPATIAL_CONFIGURATION.APPLIED_CLASSIFICATION_ASSIGNMENT'
      IN TYPEOF(ca)) ) | (NOT (SIZEOF(QUERY ( it <* aca.items | (
      NOT (
      'PLANT_SPATIAL_CONFIGURATION.PIPING_COMPONENT_DEFINITION' IN
      TYPEOF(it))) )) = 0))) )) = 0);
    wr2: (SIZEOF(QUERY ( aca <* QUERY ( ca <* USEDIN(SELF,
      'PLANT_SPATIAL_CONFIGURATION.CLASSIFICATION_ASSIGNMENT.' +
      'ASSIGNED_CLASS') |

('PLANT_SPATIAL_CONFIGURATION.APPLIED_CLASSIFICATION_ASSIGNMENT'
      IN TYPEOF(ca)) ) | (NOT (SIZEOF(QUERY ( pcd <*
      QUERY ( it <* aca.items | (
      'PLANT_SPATIAL_CONFIGURATION.PIPING_COMPONENT_DEFINITION' IN
      TYPEOF(it))) ) | (NOT (SIZEOF(QUERY ( aca1 <* USEDIN(pcd.
      formation.of_product,'PLANT_SPATIAL_CONFIGURATION.' +
      'APPLIED_CLASSIFICATION_ASSIGNMENT.ITEMS') | class_in_tree(
      aca1.assigned_class,'pipe closure') )) = 1))) )) = 0))) )) = 0);
    END_ENTITY; -- pipe_closure_fitting_class

ENTITY piping_component_class
  SUBTYPE OF (group, characterized_object);
END_ENTITY; -- piping_component_class

ENTITY piping_component_definition
  SUBTYPE OF (product_definition);
END_ENTITY; -- piping_component_definition

```

```

ENTITY piping_connector_class
  SUBTYPE OF (group);
END_ENTITY; -- piping_connector_class

ENTITY piping_spool_definition
  SUBTYPE OF (product_definition);
  WHERE
    wr1: (SIZEOF(USEDIN(SELF,'PLANT_SPATIAL_CONFIGURATION.' +
'PRODUCT_DEFINITION_RELATIONSHIP.RELATING_PRODUCT_DEFINITION'))
    > 1);
END_ENTITY; -- piping_spool_definition

ENTITY piping_support_definition
  SUBTYPE OF (product_definition);
END_ENTITY; -- piping_support_definition

ENTITY piping_support_fitting_class
  SUBTYPE OF (group);
  WHERE
    wr1: (SIZEOF(QUERY ( aca <* QUERY ( ca <* USEDIN(SELF,
'PLANT_SPATIAL_CONFIGURATION.CLASSIFICATION_ASSIGNMENT.' +
'ASSIGNED_CLASS') |
('PLANT_SPATIAL_CONFIGURATION.APPLIED_CLASSIFICATION_ASSIGNMENT'
  IN TYPEOF(ca)) ) | (NOT (SIZEOF(QUERY ( it <* aca.items | (
  NOT ('PLANT_SPATIAL_CONFIGURATION.PIPING_SUPPORT_DEFINITION'
  IN TYPEOF(it))) )) = 0)) )) = 0);
    wr2: (SIZEOF(QUERY ( aca <* QUERY ( ca <* USEDIN(SELF,
'PLANT_SPATIAL_CONFIGURATION.CLASSIFICATION_ASSIGNMENT.' +
'ASSIGNED_CLASS') |
('PLANT_SPATIAL_CONFIGURATION.APPLIED_CLASSIFICATION_ASSIGNMENT'
  IN TYPEOF(ca)) ) | (NOT (SIZEOF(QUERY ( pcd <*
  QUERY ( it <* aca.items | (
  'PLANT_SPATIAL_CONFIGURATION.PIPING_COMPONENT_DEFINITION' IN
  TYPEOF(it)) ) | (NOT (SIZEOF(QUERY ( aca1 <* USEDIN(pcd.
  formation.of_product,'PLANT_SPATIAL_CONFIGURATION.' +
  'APPLIED_CLASSIFICATION_ASSIGNMENT.ITEMS') | class_in_tree(
  aca1.assigned_class,'piping support') )) = 1)) )) = 0)) )) =
  0);
END_ENTITY; -- piping_support_fitting_class

ENTITY piping_system
  SUBTYPE OF (product_definition);
  WHERE
    wr1: (SIZEOF(QUERY ( pdr <* USEDIN(SELF,
'PLANT_SPATIAL_CONFIGURATION.' +
'PRODUCT_DEFINITION_RELATIONSHIP.RELATED_PRODUCT_DEFINITION')
  | (('PLANT_SPATIAL_CONFIGURATION.PLANT' IN TYPEOF(pdr.
  relating_product_definition.formation.of_product)) AND (pdr.
  relating_product_definition.frame_of_reference.name =
  'functional occurrence')) )) = 1);
END_ENTITY; -- piping_system

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ENTITY placement
  SUPERTYPE OF (ONEOF (axis1_placement,axis2_placement_2d,
    axis2_placement_3d))
  SUBTYPE OF (geometric_representation_item);
  location : cartesian_point;
END_ENTITY; -- placement

ENTITY plane
  SUBTYPE OF (elementary_surface);
END_ENTITY; -- plane

ENTITY plane_angle_measure_with_unit
  SUBTYPE OF (measure_with_unit);
  WHERE
    wr1: ('PLANT_SPATIAL_CONFIGURATION.PLANE_ANGLE_UNIT' IN
TYPEOF(SELF\
  measure_with_unit.unit_component));
END_ENTITY; -- plane_angle_measure_with_unit

ENTITY plane_angle_unit
  SUBTYPE OF (named_unit);
  WHERE
    wr1: ((SELF\named_unit.dimensions.length_exponent = 0) AND (SELF\
  named_unit.dimensions.mass_exponent = 0) AND (SELF\
  named_unit.dimensions.time_exponent = 0) AND (SELF\
  named_unit.dimensions.electric_current_exponent = 0) AND (
  SELF\named_unit.dimensions.
  thermodynamic_temperature_exponent = 0) AND (SELF\named_unit
  .dimensions.amount_of_substance_exponent = 0) AND (SELF\
  named_unit.dimensions.luminous_intensity_exponent = 0));
END_ENTITY; -- plane_angle_unit

ENTITY plant
  SUBTYPE OF (product);
  WHERE
    wr1: ((SIZEOF(QUERY ( pscoa <* USEDIN(SELF,
  'PLANT_SPATIAL_CONFIGURATION.' +
  'PLANT_SPATIAL_CONFIGURATION_ORGANIZATION_ASSIGNMENT.ITEMS')
  | (pscoa.role.name = 'plant operator') )) + SIZEOF(
  QUERY ( pscpaoa <* USEDIN(SELF,
  'PLANT_SPATIAL_CONFIGURATION.' +
  'PLANT_SPATIAL_CONFIGURATION_PERSON_AND_ORGANIZATION_ASSIGNMENT.'
  + 'ITEMS') | (pscpaoa.role.name = 'plant operator') ))) <= 1);
    wr2: ((SIZEOF(QUERY ( pscoa <* USEDIN(SELF,
  'PLANT_SPATIAL_CONFIGURATION.' +
  'PLANT_SPATIAL_CONFIGURATION_ORGANIZATION_ASSIGNMENT.ITEMS')
  | (pscoa.role.name = 'plant owner') )) + SIZEOF(
  QUERY ( pscpaoa <* USEDIN(SELF,

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    'PLANT_SPATIAL_CONFIGURATION.' +

'PLANT_SPATIAL_CONFIGURATION_PERSON_AND_ORGANIZATION_ASSIGNMENT.'
    + 'ITEMS') | (pscpaoa.role.name = 'plant owner') )) +
    SIZEOF(QUERY ( pscpa <* USEDIN(SELF,
    'PLANT_SPATIAL_CONFIGURATION.' +
    'PLANT_SPATIAL_CONFIGURATION_PERSON_ASSIGNMENT.ITEMS') | (
    pscpa.role.name = 'plant owner') ))) >= 1);
wr3: ((SIZEOF(QUERY ( pscoa <* USEDIN(SELF,
    'PLANT_SPATIAL_CONFIGURATION.' +

'PLANT_SPATIAL_CONFIGURATION_ORGANIZATION_ASSIGNMENT.ITEMS')
    | (pscoa\organization_assignment.role.name =
    'plant project owner') )) + SIZEOF(QUERY ( pscpaoa <*
    USEDIN(SELF,'PLANT_SPATIAL_CONFIGURATION.' +

'PLANT_SPATIAL_CONFIGURATION_PERSON_AND_ORGANIZATION_ASSIGNMENT.'
    + 'ITEMS') | (pscpaoa\person_and_organization_assignment.
    role.name = 'plant project owner') ))) >= 1);
wr4: (SIZEOF(QUERY ( pdf <* USEDIN(SELF,
    'PLANT_SPATIAL_CONFIGURATION.' +
    'PRODUCT_DEFINITION_FORMATION.OF_PRODUCT') | (NOT (SIZEOF(
    QUERY ( pd <* USEDIN(pdf,
    'PLANT_SPATIAL_CONFIGURATION.PRODUCT_DEFINITION.FORMATION')
    | (pd.frame_of_reference.name = 'functional occurrence') ))
    <= 1)) )) = 0);
END_ENTITY; -- plant

ENTITY plant_csg_shape_representation
  SUBTYPE OF (shape_representation);
WHERE
  WR1: SIZEOF (QUERY (item <* SELF.items |
    NOT (SIZEOF ([ 'PLANT_SPATIAL_CONFIGURATION.CSG_SOLID',
    'PLANT_SPATIAL_CONFIGURATION.AXIS2_PLACEMENT_3D',
    'PLANT_SPATIAL_CONFIGURATION.MAPPED_ITEM'] * TYPEOF (item)) = 1)))
    = 0;
  WR2: SIZEOF (QUERY (item <* SELF.items |
    SIZEOF ([ 'PLANT_SPATIAL_CONFIGURATION.CSG_SOLID',
    'PLANT_SPATIAL_CONFIGURATION.MAPPED_ITEM'] * TYPEOF (item))
    = 1)) >= 1;
  WR3: SIZEOF (QUERY (items <* SELF.items |
    ('PLANT_SPATIAL_CONFIGURATION.CSG_SOLID' IN TYPEOF (item)) AND
    (NOT (valid_advanced_csg_tree
      (item\csg_solid.tree_root_expression)))))) = 0;
  WR4: SIZEOF (QUERY (mi <* QUERY (item <* SELF.items |
    'PLANT_SPATIAL_CONFIGURATION.MAPPED_ITEM' IN TYPEOF (item)) |
    NOT ('PLANT_SPATIAL_CONFIGURATION.' +
    'PLANT_CSG_SHAPE_REPRESENTATION' IN
    TYPEOF (mi\mapped_item.mapping_source.mapped_representation)))) = 0;
END_ENTITY; -- plant_csg_shape_representation

ENTITY plant_design_csg_primitive
  SUBTYPE OF (shape_representation, solid_model);
WHERE
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wr1 : (SELF.context_of_items.coordinate_space_dimension = 3);
wr2 : (SELF\representation.name = SELF\representation_item.name);
wr3 : (SELF\representation.name IN ['hemisphere',
    'rectangle to ellipse','trimmed sphere','trimmed pyramid']);
wr4 : ((NOT (SELF\representation.name = 'hemisphere')) OR (SIZEOF(
    SELF.items) = 2));
wr5 : ((NOT (SELF\representation.name = 'hemisphere')) OR (SIZEOF(
    QUERY ( it <* SELF.items | ((it.name = 'position') AND (
    'PLANT_SPATIAL_CONFIGURATION.AXIS2_PLACEMENT_3D' IN TYPEOF(
    it))) )) = 1));
wr6 : ((NOT (SELF\representation.name = 'hemisphere')) OR (SIZEOF(
    QUERY ( it <* SELF.items | ((it.name = 'radius') AND (
    SIZEOF([
    'PLANT_SPATIAL_CONFIGURATION.MEASURE_REPRESENTATION_ITEM',
    'PLANT_SPATIAL_CONFIGURATION.LENGTH_MEASURE_WITH_UNIT'] *
    TYPEOF(it)) = 2)) )) = 1));
wr7 : ((NOT (SELF\representation.name = 'rectangle to ellipse')) OR
    (SIZEOF(SELF.items) = 8));
wr8 : ((NOT (SELF\representation.name = 'rectangle to ellipse')) OR
    (SIZEOF(QUERY ( it <* SELF.items | ((it.name = 'position')
    AND ('PLANT_SPATIAL_CONFIGURATION.AXIS2_PLACEMENT_3D' IN
    TYPEOF(it))) )) = 1));
wr9 : ((NOT (SELF\representation.name = 'rectangle to ellipse')) OR
    (SIZEOF(QUERY ( it <* SELF.items | ((it.name = 'x size')
    AND (SIZEOF([
    'PLANT_SPATIAL_CONFIGURATION.MEASURE_REPRESENTATION_ITEM',
    'PLANT_SPATIAL_CONFIGURATION.LENGTH_MEASURE_WITH_UNIT'] *
    TYPEOF(it)) = 2) AND (
    'PLANT_SPATIAL_CONFIGURATION.POSITIVE_LENGTH_MEASURE' IN
    TYPEOF(it\measure_with_unit.value_component)))) )) = 1));
wr10: ((NOT (SELF\representation.name = 'rectangle to ellipse')) OR
    (SIZEOF(QUERY ( it <* SELF.items | ((it.name = 'y size')
    AND (SIZEOF([
    'PLANT_SPATIAL_CONFIGURATION.MEASURE_REPRESENTATION_ITEM',
    'PLANT_SPATIAL_CONFIGURATION.LENGTH_MEASURE_WITH_UNIT'] *
    TYPEOF(it)) = 2) AND (
    'PLANT_SPATIAL_CONFIGURATION.POSITIVE_LENGTH_MEASURE' IN
    TYPEOF(it\measure_with_unit.value_component)))) )) = 1));
wr11: ((NOT (SELF\representation.name = 'rectangle to ellipse')) OR
    (SIZEOF(QUERY ( it <* SELF.items | ((it.name = 'height')
    AND (SIZEOF([
    'PLANT_SPATIAL_CONFIGURATION.MEASURE_REPRESENTATION_ITEM',
    'PLANT_SPATIAL_CONFIGURATION.LENGTH_MEASURE_WITH_UNIT'] *
    TYPEOF(it)) = 2) AND (
    'PLANT_SPATIAL_CONFIGURATION.POSITIVE_LENGTH_MEASURE' IN
    TYPEOF(it\measure_with_unit.value_component)))) )) = 1));
wr12: ((NOT (SELF\representation.name = 'rectangle to ellipse')) OR
    (SIZEOF(QUERY ( it <* SELF.items | ((it.name = 'x offset')
    AND (SIZEOF([
    'PLANT_SPATIAL_CONFIGURATION.MEASURE_REPRESENTATION_ITEM',
    'PLANT_SPATIAL_CONFIGURATION.LENGTH_MEASURE_WITH_UNIT'] *

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    TYPEOF(it) = 2)) )) = 1));
wr13: ((NOT (SELF\representation.name = 'rectangle to ellipse')) OR
    (SIZEOF(QUERY ( it <* SELF.items | ((it.name = 'y offset')
    AND (SIZEOF([
    'PLANT_SPATIAL_CONFIGURATION.MEASURE_REPRESENTATION_ITEM',
    'PLANT_SPATIAL_CONFIGURATION.LENGTH_MEASURE_WITH_UNIT'] *
    TYPEOF(it) = 2)) )) = 1));
wr14: ((NOT (SELF\representation.name = 'rectangle to ellipse')) OR
    (SIZEOF(QUERY ( it <* SELF.items | ((it.name =
    'semi axis 1') AND (SIZEOF([
    'PLANT_SPATIAL_CONFIGURATION.MEASURE_REPRESENTATION_ITEM',
    'PLANT_SPATIAL_CONFIGURATION.LENGTH_MEASURE_WITH_UNIT'] *
    TYPEOF(it) = 2)) )) = 1));
wr15: ((NOT (SELF\representation.name = 'rectangle to ellipse')) OR
    (SIZEOF(QUERY ( it <* SELF.items | ((it.name =
    'semi axis 2') AND (SIZEOF([
    'PLANT_SPATIAL_CONFIGURATION.MEASURE_REPRESENTATION_ITEM',
    'PLANT_SPATIAL_CONFIGURATION.LENGTH_MEASURE_WITH_UNIT'] *
    TYPEOF(it) = 2)) )) = 1));
wr16: ((NOT (SELF\representation.name = 'trimmed sphere')) OR (
    SIZEOF(SELF.items) = 3));
wr17: ((NOT (SELF\representation.name = 'trimmed sphere')) OR (
    SIZEOF(QUERY ( it <* SELF.items | ((it.name = 'base sphere')
    AND ('PLANT_SPATIAL_CONFIGURATION.SPHERE' IN TYPEOF(it))) ))
    = 1));
wr18: ((NOT (SELF\representation.name = 'trimmed sphere')) OR (
    SIZEOF(QUERY ( it <* SELF.items | ((it.name =
    'cutting plane normal direction') AND (
    'PLANT_SPATIAL_CONFIGURATION.DIRECTION' IN TYPEOF(it))) ))
    = 1));
wr19: ((NOT (SELF\representation.name = 'trimmed sphere')) OR (
    SIZEOF(QUERY ( it <* SELF.items | ((it.name = 'height') AND
    (SIZEOF([
    'PLANT_SPATIAL_CONFIGURATION.MEASURE_REPRESENTATION_ITEM',
    'PLANT_SPATIAL_CONFIGURATION.LENGTH_MEASURE_WITH_UNIT'] *
    TYPEOF(it) = 2)) )) = 1));
wr20: ((NOT (SELF\representation.name = 'trimmed sphere')) OR (
    SIZEOF(QUERY ( ht <* QUERY ( it <* SELF.items | ((it.name =
    'height') AND (SIZEOF([
    'PLANT_SPATIAL_CONFIGURATION.MEASURE_REPRESENTATION_ITEM',
    'PLANT_SPATIAL_CONFIGURATION.LENGTH_MEASURE_WITH_UNIT'] *
    TYPEOF(it) = 2)) ) | (NOT (SIZEOF(QUERY ( sphre <*
    QUERY ( it <* SELF.items | ((it.name = 'base sphere') AND (
    'PLANT_SPATIAL_CONFIGURATION.SPHERE' IN TYPEOF(it))) ) | (
    NOT (((-sphre.radius) < ht.value_component) AND (ht.
    value_component < sphre.radius)))) )) = 0)) )) = 0));
wr21: ((NOT (SELF\representation.name = 'trimmed pyramid')) OR (
    SIZEOF(SELF.items) = 8));
wr22: ((NOT (SELF\representation.name = 'trimmed pyramid')) OR (
    SIZEOF(QUERY ( it <* SELF.items | ((it.name =
    'base position') AND (
    'PLANT_SPATIAL_CONFIGURATION.AXIS2_PLACEMENT_3D' IN TYPEOF(
    it))) )) = 1));
wr23: ((NOT (SELF\representation.name = 'trimmed pyramid')) OR (

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        SIZEOF(QUERY ( it < * SELF.items | ((it.name = 'base length')
        AND (SIZEOF([
        'PLANT_SPATIAL_CONFIGURATION.MEASURE_REPRESENTATION_ITEM',
        'PLANT_SPATIAL_CONFIGURATION.LENGTH_MEASURE_WITH_UNIT'] *
        TYPEOF(it) = 2)) )) = 1));
wr24: ((NOT (SELF\representation.name = 'trimmed pyramid')) OR (
        SIZEOF(QUERY ( it < * SELF.items | ((it.name = 'base width')
        AND (SIZEOF([
        'PLANT_SPATIAL_CONFIGURATION.MEASURE_REPRESENTATION_ITEM',
        'PLANT_SPATIAL_CONFIGURATION.LENGTH_MEASURE_WITH_UNIT'] *
        TYPEOF(it) = 2)) )) = 1));
wr25: ((NOT (SELF\representation.name = 'trimmed pyramid')) OR (
        SIZEOF(QUERY ( it < * SELF.items | ((it.name = 'height') AND
        (SIZEOF([
        'PLANT_SPATIAL_CONFIGURATION.MEASURE_REPRESENTATION_ITEM',
        'PLANT_SPATIAL_CONFIGURATION.LENGTH_MEASURE_WITH_UNIT'] *
        TYPEOF(it) = 2)) )) = 1));
wr26: ((NOT (SELF\representation.name = 'trimmed pyramid')) OR (
        SIZEOF(QUERY ( it < * SELF.items | ((it.name =
        'top centre x') AND (SIZEOF([
        'PLANT_SPATIAL_CONFIGURATION.MEASURE_REPRESENTATION_ITEM',
        'PLANT_SPATIAL_CONFIGURATION.LENGTH_MEASURE_WITH_UNIT'] *
        TYPEOF(it) = 2)) )) = 1));
wr27: ((NOT (SELF\representation.name = 'trimmed pyramid')) OR (
        SIZEOF(QUERY ( it < * SELF.items | ((it.name =
        'top centre y') AND (SIZEOF([
        'PLANT_SPATIAL_CONFIGURATION.MEASURE_REPRESENTATION_ITEM',
        'PLANT_SPATIAL_CONFIGURATION.LENGTH_MEASURE_WITH_UNIT'] *
        TYPEOF(it) = 2)) )) = 1));
wr28: ((NOT (SELF\representation.name = 'trimmed pyramid')) OR (
        SIZEOF(QUERY ( it < * SELF.items | ((it.name = 'top length')
        AND (SIZEOF([
        'PLANT_SPATIAL_CONFIGURATION.MEASURE_REPRESENTATION_ITEM',
        'PLANT_SPATIAL_CONFIGURATION.LENGTH_MEASURE_WITH_UNIT'] *
        TYPEOF(it) = 2)) )) = 1));
wr29: ((NOT (SELF\representation.name = 'trimmed pyramid')) OR (
        SIZEOF(QUERY ( it < * SELF.items | ((it.name = 'top width')
        AND (SIZEOF([
        'PLANT_SPATIAL_CONFIGURATION.MEASURE_REPRESENTATION_ITEM',
        'PLANT_SPATIAL_CONFIGURATION.LENGTH_MEASURE_WITH_UNIT'] *
        TYPEOF(it) = 2)) )) = 1));
END_ENTITY; -- plant_design_csg_primitive

ENTITY plant_item_connection
  SUBTYPE OF (shape_aspect, shape_aspect_relationship);
  WHERE
    wr1: ('PLANT_SPATIAL_CONFIGURATION.PLANT_ITEM_CONNECTOR' IN
  TYPEOF(
    SELF\shape_aspect_relationship.relate_shape_aspect));
    wr2: ('PLANT_SPATIAL_CONFIGURATION.PLANT_ITEM_CONNECTOR' IN
  TYPEOF(

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        SELF\shape_aspect_relationship.related_shape_aspect));
wr3: (SELF\shape_aspect.of_shape\property_definition.definition\
    product_definition.frame_of_reference\
    application_context_element.name IN ['functional occurrence',
    'physical occurrence','functional definition',
    'physical definition']);
wr4: (SELF\shape_aspect_relationship.relatng_shape_aspect.of_shape\
    property_definition.definition\product_definition.
    frame_of_reference\application_context_element.name = SELF\
    shape_aspect_relationship.related_shape_aspect.of_shape\
    property_definition.definition\product_definition.
    frame_of_reference\application_context_element.name);
wr5: (SIZEOF(USEDIN(SELF,'PLANT_SPATIAL_CONFIGURATION.' +
    'APPLIED_CLASSIFICATION_ASSIGNMENT.ITEMS')) >= 1);
wr6: (SIZEOF(QUERY ( pscca <* USEDIN(SELF,
    'PLANT_SPATIAL_CONFIGURATION.' +
    'APPLIED_CLASSIFICATION_ASSIGNMENT.ITEMS') | (NOT (SIZEOF([
    'PLANT_SPATIAL_CONFIGURATION.CONNECTION_FUNCTIONAL_CLASS',
    'PLANT_SPATIAL_CONFIGURATION.CONNECTION_MOTION_CLASS'] *
    TYPEOF(pscca.assigned_class)) >= 1)) )) = 0);
wr7: (SIZEOF(QUERY ( pdr <* USEDIN(SELF.of_shape.definition,
    'PLANT_SPATIAL_CONFIGURATION.PRODUCT_DEFINITION_RELATIONSHIP.' +
    'RELATED_PRODUCT_DEFINITION') | (pdr.name =
    'support usage connection') )) <= 1);
END_ENTITY; -- plant_item_connection

ENTITY plant_item_connector
SUBTYPE OF (shape_aspect);
WHERE
    wr1 : (SELF\shape_aspect.of_shape\property_definition.definition\
        product_definition.frame_of_reference\
        application_context_element.name IN [
        'functional definition','physical definition',
        'functional occurrence','physical occurrence']);
    wr2 : (SIZEOF(QUERY ( pic <* (bag_to_set(USEDIN(SELF,
        'PLANT_SPATIAL_CONFIGURATION.' +
        'SHAPE_ASPECT_RELATIONSHIP.RELATED_SHAPE_ASPECT')) +
        bag_to_set(USEDIN(SELF,'PLANT_SPATIAL_CONFIGURATION.' +
        'SHAPE_ASPECT_RELATIONSHIP.RELATNG_SHAPE_ASPECT')) | (
        'PLANT_SPATIAL_CONFIGURATION.PLANT_ITEM_CONNECTION' IN
        TYPEOF(pic)) )) <= 1);
    wr3 : ((NOT (SIZEOF(QUERY ( aca <* USEDIN(SELF,
        'PLANT_SPATIAL_CONFIGURATION.' +
        'APPLIED_CLASSIFICATION_ASSIGNMENT.ITEMS') | (SIZEOF(
        TYPEOF(aca.assigned_class) * [
        'PLANT_SPATIAL_CONFIGURATION.PIPING_CONNECTOR_CLASS',
        'PLANT_SPATIAL_CONFIGURATION.CONNECTOR_END_TYPE_CLASS']) =
        1) )) >= 1)) OR (NOT (SIZEOF(QUERY ( pd <* USEDIN(SELF,
        'PLANT_SPATIAL_CONFIGURATION.PROPERTY_DEFINITION.DEFINITION'
        | (pd.name = 'service characteristics') )) >= 1)) OR (
        SIZEOF(QUERY ( sc <* QUERY ( pd <* USEDIN(SELF,
        'PLANT_SPATIAL_CONFIGURATION.PROPERTY_DEFINITION.DEFINITION'
        | (pd.name = 'service characteristics') ) | (NOT (SIZEOF(

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QUERY ( pdr <* USEDIN(sc,'PLANT_SPATIAL_CONFIGURATION.' +
'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') | (pdr.
used_representation.name = 'design service characteristics') ))
= 1)) )) = 0));
wr4 : ((NOT (SIZEOF(QUERY ( aca <* USEDIN(SELf,
'PLANT_SPATIAL_CONFIGURATION.' +
'APPLIED_CLASSIFICATION_ASSIGNMENT.ITEMS') | (SIZEOF(
TYPEOF(aca.assigned_class) * [
'PLANT_SPATIAL_CONFIGURATION.PIPING_CONNECTOR_CLASS',
'PLANT_SPATIAL_CONFIGURATION.CONNECTOR_END_TYPE_CLASS']) =
1)) >= 1)) OR (NOT (SIZEOF(QUERY ( pd <* USEDIN(SELf,
'PLANT_SPATIAL_CONFIGURATION.PROPERTY_DEFINITION.DEFINITION')
| (pd.name = 'service characteristics') )) >= 1)) OR (
SIZEOF(QUERY ( sc <* QUERY ( pd <* USEDIN(SELf,
'PLANT_SPATIAL_CONFIGURATION.PROPERTY_DEFINITION.DEFINITION')
| (pd.name = 'service characteristics') ) | (NOT (SIZEOF(
QUERY ( dsc <* QUERY ( pdr <* USEDIN(sc,
'PLANT_SPATIAL_CONFIGURATION.' +
'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') | (pdr.
used_representation.name = 'design service characteristics') )
| (SIZEOF(dsc.used_representation.items) >= 2)) = 1)) ))
= 0));
wr5 : ((NOT (SIZEOF(QUERY ( aca <* USEDIN(SELf,
'PLANT_SPATIAL_CONFIGURATION.' +
'APPLIED_CLASSIFICATION_ASSIGNMENT.ITEMS') | (SIZEOF(
TYPEOF(aca.assigned_class) * [
'PLANT_SPATIAL_CONFIGURATION.PIPING_CONNECTOR_CLASS',
'PLANT_SPATIAL_CONFIGURATION.CONNECTOR_END_TYPE_CLASS']) =
1)) >= 1)) OR (NOT (SIZEOF(QUERY ( pd <* USEDIN(SELf,
'PLANT_SPATIAL_CONFIGURATION.PROPERTY_DEFINITION.DEFINITION')
| (pd.name = 'service characteristics') )) >= 1)) OR (
SIZEOF(QUERY ( sc <* QUERY ( pd <* USEDIN(SELf,
'PLANT_SPATIAL_CONFIGURATION.PROPERTY_DEFINITION.DEFINITION')
| (pd.name = 'service characteristics') ) | (NOT (SIZEOF(
QUERY ( dsc <* QUERY ( pdr <* USEDIN(sc,
'PLANT_SPATIAL_CONFIGURATION.' +
'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') | (pdr.
used_representation.name = 'design service characteristics') )
| ((1 <= SIZEOF(QUERY ( it <* dsc.used_representation.
items | ((
'PLANT_SPATIAL_CONFIGURATION.MEASURE_REPRESENTATION_ITEM'
IN TYPEOF(it)) AND (it.name IN ['pressure',
'minimum pressure','maximum pressure'])) ))) AND (SIZEOF(
QUERY ( it <* dsc.used_representation.items | ((
'PLANT_SPATIAL_CONFIGURATION.MEASURE_REPRESENTATION_ITEM'
IN TYPEOF(it)) AND (it.name IN ['pressure',
'minimum pressure','maximum pressure'])) )) <= 2)) = 1)) ))
= 0));
wr6 : ((NOT (SIZEOF(QUERY ( aca <* USEDIN(SELf,
'PLANT_SPATIAL_CONFIGURATION.' +
'APPLIED_CLASSIFICATION_ASSIGNMENT.ITEMS') | (SIZEOF(

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    TYPEOF(aca.assigned_class) * [
    'PLANT_SPATIAL_CONFIGURATION.PIPING_CONNECTOR_CLASS',
    'PLANT_SPATIAL_CONFIGURATION.CONNECTOR_END_TYPE_CLASS']) =
1) )) >= 1)) OR (NOT (SIZEOF(QUERY ( pd <* USEDIN(SELF,
'PLANT_SPATIAL_CONFIGURATION.PROPERTY_DEFINITION.DEFINITION')
| (pd.name = 'service characteristics') )) >= 1)) OR (
SIZEOF(QUERY ( sc <* QUERY ( pd <* USEDIN(SELF,
'PLANT_SPATIAL_CONFIGURATION.PROPERTY_DEFINITION.DEFINITION')
| (pd.name = 'service characteristics') ) | (NOT (SIZEOF(
QUERY ( dsc <* QUERY ( pdr <* USEDIN(sc,
'PLANT_SPATIAL_CONFIGURATION.' +
'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') | (pdr.
used_representation.name = 'design service characteristics') )
| (SIZEOF(QUERY ( it <* dsc.used_representation.items | ((
'PLANT_SPATIAL_CONFIGURATION.MEASURE_REPRESENTATION_ITEM'
IN TYPEOF(it)) AND (it.name = 'pressure')) )) <= 1) )) = 1)) ))
= 0));
wr7 : ((NOT (SIZEOF(QUERY ( aca <* USEDIN(SELF,
'PLANT_SPATIAL_CONFIGURATION.' +
'APPLIED_CLASSIFICATION_ASSIGNMENT.ITEMS') | (SIZEOF(
TYPEOF(aca.assigned_class) * [
'PLANT_SPATIAL_CONFIGURATION.PIPING_CONNECTOR_CLASS',
'PLANT_SPATIAL_CONFIGURATION.CONNECTOR_END_TYPE_CLASS']) =
1) )) >= 1)) OR (NOT (SIZEOF(QUERY ( pd <* USEDIN(SELF,
'PLANT_SPATIAL_CONFIGURATION.PROPERTY_DEFINITION.DEFINITION')
| (pd.name = 'service characteristics') )) >= 1)) OR (
SIZEOF(QUERY ( sc <* QUERY ( pd <* USEDIN(SELF,
'PLANT_SPATIAL_CONFIGURATION.PROPERTY_DEFINITION.DEFINITION')
| (pd.name = 'service characteristics') ) | (NOT (SIZEOF(
QUERY ( dsc <* QUERY ( pdr <* USEDIN(sc,
'PLANT_SPATIAL_CONFIGURATION.' +
'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') | (pdr.
used_representation.name = 'design service characteristics') )
| (SIZEOF(QUERY ( it <* dsc.used_representation.items | ((
'PLANT_SPATIAL_CONFIGURATION.MEASURE_REPRESENTATION_ITEM'
IN TYPEOF(it)) AND (it.name = 'minimum pressure')) )) <= 1) ))
= 1)) )) = 0));
wr8 : ((NOT (SIZEOF(QUERY ( aca <* USEDIN(SELF,
'PLANT_SPATIAL_CONFIGURATION.' +
'APPLIED_CLASSIFICATION_ASSIGNMENT.ITEMS') | (SIZEOF(
TYPEOF(aca.assigned_class) * [
'PLANT_SPATIAL_CONFIGURATION.PIPING_CONNECTOR_CLASS',
'PLANT_SPATIAL_CONFIGURATION.CONNECTOR_END_TYPE_CLASS']) =
1) )) >= 1)) OR (NOT (SIZEOF(QUERY ( pd <* USEDIN(SELF,
'PLANT_SPATIAL_CONFIGURATION.PROPERTY_DEFINITION.DEFINITION')
| (pd.name = 'service characteristics') )) >= 1)) OR (
SIZEOF(QUERY ( sc <* QUERY ( pd <* USEDIN(SELF,
'PLANT_SPATIAL_CONFIGURATION.PROPERTY_DEFINITION.DEFINITION')
| (pd.name = 'service characteristics') ) | (NOT (SIZEOF(
QUERY ( dsc <* QUERY ( pdr <* USEDIN(sc,
'PLANT_SPATIAL_CONFIGURATION.' +
'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') | (pdr.
used_representation.name = 'design service characteristics') )
| (SIZEOF(QUERY ( it <* dsc.used_representation.items | ((

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    'PLANT_SPATIAL_CONFIGURATION.MEASURE_REPRESENTATION_ITEM'
    IN TYPEOF(it)) AND (it.name = 'maximum pressure')) )) <= 1) ))
    = 1)) )) = 0));
wr9 : ((NOT (SIZEOF(QUERY ( aca <* USEDIN(SELF,
    'PLANT_SPATIAL_CONFIGURATION.' +
    'APPLIED_CLASSIFICATION_ASSIGNMENT.ITEMS') | (SIZEOF(
    TYPEOF(aca.assigned_class) * [
    'PLANT_SPATIAL_CONFIGURATION.PIPING_CONNECTOR_CLASS',
    'PLANT_SPATIAL_CONFIGURATION.CONNECTOR_END_TYPE_CLASS']) =
    1) )) >= 1)) OR (NOT (SIZEOF(QUERY ( pd <* USEDIN(SELF,
    'PLANT_SPATIAL_CONFIGURATION.PROPERTY_DEFINITION.DEFINITION'
    | (pd.name = 'service characteristics') )) >= 1)) OR (
    SIZEOF(QUERY ( sc <* QUERY ( pd <* USEDIN(SELF,
    'PLANT_SPATIAL_CONFIGURATION.PROPERTY_DEFINITION.DEFINITION'
    | (pd.name = 'service characteristics') ) | (NOT (SIZEOF(
    QUERY ( dsc <* QUERY ( pdr <* USEDIN(sc,
    'PLANT_SPATIAL_CONFIGURATION.' +
    'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') | (pdr.
    used_representation.name = 'design service characteristics') )
    | ((1 <= SIZEOF(QUERY ( it <* dsc.used_representation.
    items | ((SIZEOF(TYPEOF(it) * [
    'PLANT_SPATIAL_CONFIGURATION.MEASURE_REPRESENTATION_ITEM',
    'PLANT_SPATIAL_CONFIGURATION.' +
    'THERMODYNAMIC_TEMPERATURE_MEASURE_WITH_UNIT']) = 2) AND (
    it.name IN ['temperature','minimum temperature',
    'maximum temperature']))) )) AND (SIZEOF(QUERY ( it <* dsc.
    used_representation.items | ((SIZEOF(TYPEOF(it) * [
    'PLANT_SPATIAL_CONFIGURATION.MEASURE_REPRESENTATION_ITEM',
    'PLANT_SPATIAL_CONFIGURATION.' +
    'THERMODYNAMIC_TEMPERATURE_MEASURE_WITH_UNIT']) = 2) AND (
    it.name IN ['temperature','minimum temperature',
    'maximum temperature']))) )) <= 2)) )) = 1)) )) = 0));
wr10: ((NOT (SIZEOF(QUERY ( aca <* USEDIN(SELF,
    'PLANT_SPATIAL_CONFIGURATION.' +
    'APPLIED_CLASSIFICATION_ASSIGNMENT.ITEMS') | (SIZEOF(
    TYPEOF(aca.assigned_class) * [
    'PLANT_SPATIAL_CONFIGURATION.PIPING_CONNECTOR_CLASS',
    'PLANT_SPATIAL_CONFIGURATION.CONNECTOR_END_TYPE_CLASS']) =
    1) )) >= 1)) OR (NOT (SIZEOF(QUERY ( pd <* USEDIN(SELF,
    'PLANT_SPATIAL_CONFIGURATION.PROPERTY_DEFINITION.DEFINITION'
    | (pd.name = 'service characteristics') )) >= 1)) OR (
    SIZEOF(QUERY ( sc <* QUERY ( pd <* USEDIN(SELF,
    'PLANT_SPATIAL_CONFIGURATION.PROPERTY_DEFINITION.DEFINITION'
    | (pd.name = 'service characteristics') ) | (NOT (SIZEOF(
    QUERY ( dsc <* QUERY ( pdr <* USEDIN(sc,
    'PLANT_SPATIAL_CONFIGURATION.' +
    'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') | (pdr.
    used_representation.name = 'design service characteristics') )
    | (SIZEOF(QUERY ( it <* dsc.used_representation.items | ((
    SIZEOF(TYPEOF(it) * [
    'PLANT_SPATIAL_CONFIGURATION.MEASURE_REPRESENTATION_ITEM',

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'PLANT_SPATIAL_CONFIGURATION.' +
'THERMODYNAMIC_TEMPERATURE_MEASURE_WITH_UNIT')) = 2) AND (
it.name = 'temperature')) )) <= 1) )) = 1)) )) = 0));
wr11: ((NOT (SIZEOF(QUERY ( aca <* USEDIN(SELF,
'PLANT_SPATIAL_CONFIGURATION.' +
'APPLIED_CLASSIFICATION_ASSIGNMENT.ITEMS') | (SIZEOF(
TYPEOF(aca.assigned_class) * [
'PLANT_SPATIAL_CONFIGURATION.PIPING_CONNECTOR_CLASS',
'PLANT_SPATIAL_CONFIGURATION.CONNECTOR_END_TYPE_CLASS']) =
1) )) >= 1)) OR (NOT (SIZEOF(QUERY ( pd <* USEDIN(SELF,
'PLANT_SPATIAL_CONFIGURATION.PROPERTY_DEFINITION.DEFINITION'
| (pd.name = 'service characteristics') )) >= 1)) OR (
SIZEOF(QUERY ( sc <* QUERY ( pd <* USEDIN(SELF,
'PLANT_SPATIAL_CONFIGURATION.PROPERTY_DEFINITION.DEFINITION'
| (pd.name = 'service characteristics') ) | (NOT (SIZEOF(
QUERY ( dsc <* QUERY ( pdr <* USEDIN(sc,
'PLANT_SPATIAL_CONFIGURATION.' +
'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') | (pdr.
used_representation.name = 'design service characteristics') )
| (SIZEOF(QUERY ( it <* dsc.used_representation.items | ((
SIZEOF(TYPEOF(it) * [
'PLANT_SPATIAL_CONFIGURATION.MEASURE_REPRESENTATION_ITEM',
'PLANT_SPATIAL_CONFIGURATION.' +
'THERMODYNAMIC_TEMPERATURE_MEASURE_WITH_UNIT')) = 2) AND (
it.name = 'minimum temperature')) )) <= 1) )) = 1)) )) = 0));
wr12: ((NOT (SIZEOF(QUERY ( aca <* USEDIN(SELF,
'PLANT_SPATIAL_CONFIGURATION.' +
'APPLIED_CLASSIFICATION_ASSIGNMENT.ITEMS') | (SIZEOF(
TYPEOF(aca.assigned_class) * [
'PLANT_SPATIAL_CONFIGURATION.PIPING_CONNECTOR_CLASS',
'PLANT_SPATIAL_CONFIGURATION.CONNECTOR_END_TYPE_CLASS']) =
1) )) >= 1)) OR (NOT (SIZEOF(QUERY ( pd <* USEDIN(SELF,
'PLANT_SPATIAL_CONFIGURATION.PROPERTY_DEFINITION.DEFINITION'
| (pd.name = 'service characteristics') )) >= 1)) OR (
SIZEOF(QUERY ( sc <* QUERY ( pd <* USEDIN(SELF,
'PLANT_SPATIAL_CONFIGURATION.PROPERTY_DEFINITION.DEFINITION'
| (pd.name = 'service characteristics') ) | (NOT (SIZEOF(
QUERY ( dsc <* QUERY ( pdr <* USEDIN(sc,
'PLANT_SPATIAL_CONFIGURATION.' +
'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') | (pdr.
used_representation.name = 'design service characteristics') )
| (SIZEOF(QUERY ( it <* dsc.used_representation.items | ((
SIZEOF(TYPEOF(it) * [
'PLANT_SPATIAL_CONFIGURATION.MEASURE_REPRESENTATION_ITEM',
'PLANT_SPATIAL_CONFIGURATION.' +
'THERMODYNAMIC_TEMPERATURE_MEASURE_WITH_UNIT')) = 2) AND (
it.name = 'maximum temperature')) )) <= 1) )) = 1)) )) = 0));
wr13: ((NOT (SELF\shape_aspect.of_shape\property_definition.
definition\product_definition.frame_of_reference\
application_context_element.name IN [
'functional definition','functional occurrence']))) OR (
SIZEOF(QUERY ( pdr <* USEDIN(SELF,
'PLANT_SPATIAL_CONFIGURATION.' +
'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') | (

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        'PLANT_SPATIAL_CONFIGURATION.SHAPE_REPRESENTATION' IN
        TYPEOF(pdr.used_representation)) )) = 0));
END_ENTITY; -- plant_item_connector

ENTITY plant_item_interference
    SUBTYPE OF (product_definition_relationship);
END_ENTITY; -- plant_item_interference

ENTITY plant_item_route
    SUBTYPE OF (product_definition_shape);
    WHERE
        wr1: (SELF\property_definition.definition\product_definition.
            frame_of_reference\application_context_element.name =
            'physical occurrence');
        wr2: (SIZEOF(TYPEOF(SELF\property_definition.definition) * [
            'PLANT_SPATIAL_CONFIGURATION.PLANT_LINE_DEFINITION',
            'PLANT_SPATIAL_CONFIGURATION.PLANT_LINE_SEGMENT_DEFINITION'])
            = 1);
END_ENTITY; -- plant_item_route

ENTITY plant_item_weight_representation
    SUBTYPE OF (property_definition_representation);
    WHERE
        wr1: (SELF.used_representation.name = 'item weight');
        wr2: (SIZEOF(SELF.used_representation.items) >= 2);
        wr3: (SIZEOF(QUERY ( it <= SELF.used_representation.items | ((it.
            name IN ['weight value','maximum weight value',
            'minimum weight value']) AND (NOT (SIZEOF(TYPEOF(it) * [
            'PLANT_SPATIAL_CONFIGURATION.MEASURE_REPRESENTATION_ITEM',
            'PLANT_SPATIAL_CONFIGURATION.QUALIFIED_REPRESENTATION_ITEM'])
            = 2))) )) = 0);
        wr4: (SIZEOF(QUERY ( it <= SELF.used_representation.items | ((
            'PLANT_SPATIAL_CONFIGURATION.GEOMETRIC_REPRESENTATION_ITEM'
            IN TYPEOF(it)) AND (it.name = 'centre of gravity')) )) = 1);
        wr5: ((1 <= SIZEOF(QUERY ( it <= SELF.used_representation.items | (
            it.name IN ['weight value','maximum weight value',
            'minimum weight value']) ))) AND (SIZEOF(QUERY ( it <= SELF.
            used_representation.items | (it.name IN ['weight value',
            'maximum weight value','minimum weight value']) )) <= 2));
        wr6: (SIZEOF(QUERY ( it <= SELF\property_definition_representation.
            used_representation.items | ((it.name IN [
            'maximum weight value','minimum weight value']) AND (NOT (
            SIZEOF(QUERY ( tq <= QUERY ( qual <= it\
            qualified_representation_item.qualifiers | (
            'PLANT_SPATIAL_CONFIGURATION.TYPE_QUALIFIER' IN TYPEOF(qual)) )
            | (tq.name = 'operating') )) = 1))) )) = 0);
END_ENTITY; -- plant_item_weight_representation

ENTITY plant_line_definition
    SUBTYPE OF (product_definition_with_associated_documents);
    WHERE

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wr1: (SIZEOF(QUERY ( pdr <* USEDIN(SELF,
    'PLANT_SPATIAL_CONFIGURATION.' +
    'PRODUCT_DEFINITION_RELATIONSHIP.RELATED_PRODUCT_DEFINITION')
    | ('PLANT_SPATIAL_CONFIGURATION.PIPING_SYSTEM' IN TYPEOF(
        pdr.relater_product_definition))) ) = 1);
wr2: (SIZEOF(QUERY ( pdr <* USEDIN(SELF,
    'PLANT_SPATIAL_CONFIGURATION.' +
    'PRODUCT_DEFINITION_RELATIONSHIP.ROUTING_PRODUCT_DEFINITION')
    |
    ('PLANT_SPATIAL_CONFIGURATION.PLANT_LINE_SEGMENT_DEFINITION'
    IN TYPEOF(pdr.related_product_definition))) ) >= 1);
wr3: ((NOT (SIZEOF(QUERY ( pd <* USEDIN(SELF,
    'PLANT_SPATIAL_CONFIGURATION.PROPERTY_DEFINITION.DEFINITION')
    | (SIZEOF(USEDIN(pd,'PLANT_SPATIAL_CONFIGURATION.' +
    'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION')) >= 1) )) =
    0)) OR (SIZEOF(QUERY ( pd <* USEDIN(SELF,
    'PLANT_SPATIAL_CONFIGURATION.PROPERTY_DEFINITION.DEFINITION')
    | (NOT (SIZEOF(QUERY ( pdr <* USEDIN(pd,
    'PLANT_SPATIAL_CONFIGURATION.' +
    'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') | (SIZEOF(
    QUERY ( rep <* USEDIN(pdr.used_representation.context_of_items,
    'PLANT_SPATIAL_CONFIGURATION.REPRESENTATION.CONTEXT_OF_ITEMS')
    | (SIZEOF(QUERY ( prop_def_rep <* USEDIN(rep,
    'PLANT_SPATIAL_CONFIGURATION.' +
    'PROPERTY_DEFINITION_REPRESENTATION.USED_REPRESENTATION') |
    ((SIZEOF(['PLANT_SPATIAL_CONFIGURATION.SITE',
    'PLANT_SPATIAL_CONFIGURATION.SITE_BUILDING'] * TYPEOF(
    prop_def_rep.definition)) = 1) OR (
    'PLANT_SPATIAL_CONFIGURATION.PLANT' IN TYPEOF(prop_def_rep.
    definition.definition.formation.of_product))) ) >= 1) )) >=
    1) )) >= 1) )) = 0));
wr4: (SELF.frame_of_reference.name = 'functional definition');
wr5: (SIZEOF(QUERY ( pds <* QUERY ( pd <* USEDIN(SELF,
    'PLANT_SPATIAL_CONFIGURATION.PROPERTY_DEFINITION.DEFINITION')
    | ('PLANT_SPATIAL_CONFIGURATION.PRODUCT_DEFINITION_SHAPE'
    IN TYPEOF(pd)) ) | (NOT (SIZEOF(QUERY ( sa <* USEDIN(pds,
    'PLANT_SPATIAL_CONFIGURATION.SHAPE_ASPECT.OF_SHAPE') |
    (('PLANT_SPATIAL_CONFIGURATION.PLANT_LINE_SEGMENT_TERMINATION'
    IN TYPEOF(sa)) AND (sa.description =
    'piping line termination')) ) <= 2)) ) = 0);
END_ENTITY; -- plant_line_definition

ENTITY plant_line_segment_definition
SUBTYPE OF (product_definition);
WHERE
    wr1 : (SIZEOF(QUERY ( pdr <* USEDIN(SELF,
        'PLANT_SPATIAL_CONFIGURATION.' +
        'PRODUCT_DEFINITION_RELATIONSHIP.RELATED_PRODUCT_DEFINITION')
        | ('PLANT_SPATIAL_CONFIGURATION.PLANT_LINE_DEFINITION' IN
        TYPEOF(pdr.relater_product_definition))) ) >= 1);

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wr2 : (SIZEOF(QUERY ( pd <* USEDIN(SELf,
    'PLANT_SPATIAL_CONFIGURATION.PROPERTY_DEFINITION.DEFINITION')
    | ('PLANT_SPATIAL_CONFIGURATION.SHAPE_DEFINITION' IN
    TYPEOF(pd)) )) >= 1);
wr3 : (SELF.frame_of_reference\application_context_element.name =
    'functional definition');
wr4 : (SIZEOF(QUERY ( pdr <* USEDIN(SELf,
    'PLANT_SPATIAL_CONFIGURATION.' +
    'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') | (pdr.
    used_representation.name = 'line segment characteristics') ))
    = 1);
wr5 : (SIZEOF(QUERY ( lsc <* QUERY ( pdr <* USEDIN(SELf,
    'PLANT_SPATIAL_CONFIGURATION.' +
    'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') | (pdr.
    used_representation.name = 'line segment characteristics') )
    | (NOT (SIZEOF(lsc.used_representation.items) >= 2)) )) =
    0);
wr6 : (SIZEOF(QUERY ( lsc <* QUERY ( pdr <* USEDIN(SELf,
    'PLANT_SPATIAL_CONFIGURATION.' +
    'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') | (pdr.
    used_representation.name = 'line segment characteristics') )
    | (NOT (SIZEOF(QUERY ( it <* lsc.used_representation.items
    | ((
    'PLANT_SPATIAL_CONFIGURATION.MEASURE_REPRESENTATION_ITEM'
    IN TYPEOF(it)) AND (it.name = 'design pressure')) )) = 1))) ))
    = 0);
wr7 : (SIZEOF(QUERY ( lsc <* QUERY ( pdr <* USEDIN(SELf,
    'PLANT_SPATIAL_CONFIGURATION.' +
    'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') | (pdr.
    used_representation.name = 'line segment characteristics') )
    | (NOT (SIZEOF(QUERY ( it <* lsc.used_representation.items
    | ((SIZEOF(TYPEOF(it)) * [
    'PLANT_SPATIAL_CONFIGURATION.MEASURE_REPRESENTATION_ITEM',
    'PLANT_SPATIAL_CONFIGURATION.' +
    'THERMODYNAMIC_TEMPERATURE_MEASURE_WITH_UNIT']) = 2) AND (
    it.name = 'design temperature')) )) = 1))) )) = 0);
wr8 : (SIZEOF(QUERY ( lsc <* QUERY ( pdr <* USEDIN(SELf,
    'PLANT_SPATIAL_CONFIGURATION.' +
    'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') | (pdr.
    used_representation.name = 'line segment characteristics') )
    | (NOT (SIZEOF(QUERY ( it <* lsc.used_representation.items
    | ((SIZEOF(TYPEOF(it)) * [
    'PLANT_SPATIAL_CONFIGURATION.MEASURE_REPRESENTATION_ITEM',
    'PLANT_SPATIAL_CONFIGURATION.LENGTH_MEASURE_WITH_UNIT']) =
    2) AND (it.name = 'elevation')) )) <= 1))) )) = 0);
wr9 : (SIZEOF(QUERY ( lsc <* QUERY ( pdr <* USEDIN(SELf,
    'PLANT_SPATIAL_CONFIGURATION.' +
    'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') | (pdr.
    used_representation.name = 'line segment characteristics') )
    | (NOT (SIZEOF(QUERY ( it <* lsc.used_representation.items
    | ((

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'PLANT_SPATIAL_CONFIGURATION.MEASURE_REPRESENTATION_ITEM'
IN TYPEOF(it)) AND (it.name = 'corrosion allowance')) )) <=
1)) )) = 0);
wr10: ((NOT (SIZEOF(QUERY ( pdr <* USEDIN(SELF,
'PLANT_SPATIAL_CONFIGURATION.' +
'PRODUCT_DEFINITION_RELATIONSHIP.RELATED_PRODUCT_DEFINITION')
| (pdr.name = 'segment insulation') )) >= 1)) OR (SIZEOF(
QUERY ( si <* QUERY ( pdr <* USEDIN(SELF,
'PLANT_SPATIAL_CONFIGURATION.' +
'PRODUCT_DEFINITION_RELATIONSHIP.RELATED_PRODUCT_DEFINITION')
| (pdr.name = 'segment insulation') ) | (NOT (SIZEOF(
QUERY ( pd <* USEDIN(si,
'PLANT_SPATIAL_CONFIGURATION.PROPERTY_DEFINITION.DEFINITION')
| (NOT (SIZEOF(QUERY ( pds <* QUERY ( pdr <* USEDIN(pd,
'PLANT_SPATIAL_CONFIGURATION.' +
'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') | (
'PLANT_SPATIAL_CONFIGURATION.PRODUCT_DEFINITION_SHAPE' IN
TYPEOF(pdr)) ) | (pds.used_representation.name =
'segment insulation characteristics') )) = 1)) )) = 0)) ))
= 0));
wr11: ((NOT (SIZEOF(QUERY ( pdr <* USEDIN(SELF,
'PLANT_SPATIAL_CONFIGURATION.' +
'PRODUCT_DEFINITION_RELATIONSHIP.RELATED_PRODUCT_DEFINITION')
| (pdr.name = 'segment insulation') )) >= 1)) OR (SIZEOF(
QUERY ( si <* QUERY ( pdr <* USEDIN(SELF,
'PLANT_SPATIAL_CONFIGURATION.' +
'PRODUCT_DEFINITION_RELATIONSHIP.RELATED_PRODUCT_DEFINITION')
| (pdr.name = 'segment insulation') ) | (NOT (SIZEOF(
QUERY ( pd <* USEDIN(si,
'PLANT_SPATIAL_CONFIGURATION.PROPERTY_DEFINITION.DEFINITION')
| (NOT (SIZEOF(QUERY ( sic <* QUERY ( pds <*
QUERY ( pdr <* USEDIN(pd,'PLANT_SPATIAL_CONFIGURATION.' +
'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') | (
'PLANT_SPATIAL_CONFIGURATION.PRODUCT_DEFINITION_SHAPE' IN
TYPEOF(pdr)) ) | (pds.used_representation.name =
'segment insulation characteristics') ) | (SIZEOF(sic.
used_representation.items) >= 1) )) = 1)) )) = 0)) )) = 0));
wr12: ((NOT (SIZEOF(QUERY ( pdr <* USEDIN(SELF,
'PLANT_SPATIAL_CONFIGURATION.' +
'PRODUCT_DEFINITION_RELATIONSHIP.RELATED_PRODUCT_DEFINITION')
| (pdr.name = 'segment insulation') )) >= 1)) OR (SIZEOF(
QUERY ( si <* QUERY ( pdr <* USEDIN(SELF,
'PLANT_SPATIAL_CONFIGURATION.' +
'PRODUCT_DEFINITION_RELATIONSHIP.RELATED_PRODUCT_DEFINITION')
| (pdr.name = 'segment insulation') ) | (NOT (SIZEOF(
QUERY ( pd <* USEDIN(si,
'PLANT_SPATIAL_CONFIGURATION.PROPERTY_DEFINITION.DEFINITION')
| (NOT (SIZEOF(QUERY ( sic <* QUERY ( pds <*
QUERY ( pdr <* USEDIN(pd,'PLANT_SPATIAL_CONFIGURATION.' +

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'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') | (
'PLANT_SPATIAL_CONFIGURATION.PRODUCT_DEFINITION_SHAPE' IN
TYPEOF(pdr)) ) | (pds.used_representation.name =
'segment insulation characteristics') ) | ((1 <= SIZEOF(
QUERY ( it <* sic.used_representation.items | ((SIZEOF(
TYPEOF(it) * [
'PLANT_SPATIAL_CONFIGURATION.MEASURE_REPRESENTATION_ITEM',
'PLANT_SPATIAL_CONFIGURATION.LENGTH_MEASURE_WITH_UNIT']) =
2) AND (it.name IN ['thickness','minimum thickness',
'maximum thickness'])) ))) AND (SIZEOF(QUERY ( it <* sic.
used_representation.items | ((SIZEOF(TYPEOF(it) * [
'PLANT_SPATIAL_CONFIGURATION.MEASURE_REPRESENTATION_ITEM',
'PLANT_SPATIAL_CONFIGURATION.LENGTH_MEASURE_WITH_UNIT']) =
2) AND (it.name IN ['thickness','minimum thickness',
'maximum thickness'])) )) <= 2)) )) = 1)) )) = 0)) )) = 0));
wr13: ((NOT (SIZEOF(QUERY ( pdr <* USEDIN(SELF,
'PLANT_SPATIAL_CONFIGURATION.' +

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'PRODUCT_DEFINITION_RELATIONSHIP.RELATED_PRODUCT_DEFINITION')
| (pdr.name = 'segment insulation') )) >= 1)) OR (SIZEOF(
QUERY ( si <* QUERY ( pdr <* USEDIN(SELF,
'PLANT_SPATIAL_CONFIGURATION.' +

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'PRODUCT_DEFINITION_RELATIONSHIP.RELATED_PRODUCT_DEFINITION')
| (pdr.name = 'segment insulation') ) | (NOT (SIZEOF(
QUERY ( pd <* USEDIN(si,
'PLANT_SPATIAL_CONFIGURATION.PROPERTY_DEFINITION.DEFINITION')
| (NOT (SIZEOF(QUERY ( sic <* QUERY ( pds <*
QUERY ( pdr <* USEDIN(pd,'PLANT_SPATIAL_CONFIGURATION.' +
'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') | (
'PLANT_SPATIAL_CONFIGURATION.PRODUCT_DEFINITION_SHAPE' IN
TYPEOF(pdr)) ) | (pds.used_representation.name =
'segment insulation characteristics') ) | (SIZEOF(
QUERY ( it <* sic.used_representation.items | ((SIZEOF(
TYPEOF(it) * [
'PLANT_SPATIAL_CONFIGURATION.MEASURE_REPRESENTATION_ITEM',
'PLANT_SPATIAL_CONFIGURATION.LENGTH_MEASURE_WITH_UNIT']) =
2) AND (it.name = 'thickness')) )) <= 1)) )) = 1)) )) = 0)) ))
= 0));
wr14: ((NOT (SIZEOF(QUERY ( pdr <* USEDIN(SELF,
'PLANT_SPATIAL_CONFIGURATION.' +

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'PRODUCT_DEFINITION_RELATIONSHIP.RELATED_PRODUCT_DEFINITION')
| (pdr.name = 'segment insulation') )) >= 1)) OR (SIZEOF(
QUERY ( si <* QUERY ( pdr <* USEDIN(SELF,
'PLANT_SPATIAL_CONFIGURATION.' +

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'PRODUCT_DEFINITION_RELATIONSHIP.RELATED_PRODUCT_DEFINITION')
| (pdr.name = 'segment insulation') ) | (NOT (SIZEOF(
QUERY ( pd <* USEDIN(si,
'PLANT_SPATIAL_CONFIGURATION.PROPERTY_DEFINITION.DEFINITION')

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| (NOT (SIZEOF(QUERY ( sic <* QUERY ( pds <*
QUERY ( pdr <* USEDIN(pd,'PLANT_SPATIAL_CONFIGURATION.' +
'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') | (
'PLANT_SPATIAL_CONFIGURATION.PRODUCT_DEFINITION_SHAPE' IN
TYPEOF(pdr)) ) | (pds.used_representation.name =
'segment insulation characteristics') ) | (SIZEOF(
QUERY ( it <* sic.used_representation.items | ((SIZEOF(
TYPEOF(it) * [
'PLANT_SPATIAL_CONFIGURATION.MEASURE_REPRESENTATION_ITEM',
'PLANT_SPATIAL_CONFIGURATION.LENGTH_MEASURE_WITH_UNIT']) =
2) AND (it.name = 'minimum thickness')) ) <= 1) ) = 1) ) )
= 0) ) = 0));
wr15: ((NOT (SIZEOF(QUERY ( pdr <* USEDIN(SELF,
'PLANT_SPATIAL_CONFIGURATION.' +
'PRODUCT_DEFINITION_RELATIONSHIP.RELATED_PRODUCT_DEFINITION')
| (pdr.name = 'segment insulation') ) >= 1) ) OR (SIZEOF(
QUERY ( si <* QUERY ( pdr <* USEDIN(SELF,
'PLANT_SPATIAL_CONFIGURATION.' +
'PRODUCT_DEFINITION_RELATIONSHIP.RELATED_PRODUCT_DEFINITION')
| (pdr.name = 'segment insulation') ) | (NOT (SIZEOF(
QUERY ( pd <* USEDIN(si,
'PLANT_SPATIAL_CONFIGURATION.PROPERTY_DEFINITION.DEFINITION')
| (NOT (SIZEOF(QUERY ( sic <* QUERY ( pds <*
QUERY ( pdr <* USEDIN(pd,'PLANT_SPATIAL_CONFIGURATION.' +
'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') | (
'PLANT_SPATIAL_CONFIGURATION.PRODUCT_DEFINITION_SHAPE' IN
TYPEOF(pdr)) ) | (pds.used_representation.name =
'segment insulation characteristics') ) | (SIZEOF(
QUERY ( it <* sic.used_representation.items | ((SIZEOF(
TYPEOF(it) * [
'PLANT_SPATIAL_CONFIGURATION.MEASURE_REPRESENTATION_ITEM',
'PLANT_SPATIAL_CONFIGURATION.LENGTH_MEASURE_WITH_UNIT']) =
2) AND (it.name = 'maximum thickness')) ) <= 1) ) = 1) ) )
= 0) ) = 0));
wr16: ((NOT (SIZEOF(QUERY ( pdr <* USEDIN(SELF,
'PLANT_SPATIAL_CONFIGURATION.' +
'PRODUCT_DEFINITION_RELATIONSHIP.RELATED_PRODUCT_DEFINITION')
| (pdr.name = 'segment insulation') ) >= 1) ) OR (SIZEOF(
QUERY ( si <* QUERY ( pdr <* USEDIN(SELF,
'PLANT_SPATIAL_CONFIGURATION.' +
'PRODUCT_DEFINITION_RELATIONSHIP.RELATED_PRODUCT_DEFINITION')
| (pdr.name = 'segment insulation') ) | (NOT (SIZEOF(
QUERY ( pd <* USEDIN(si,
'PLANT_SPATIAL_CONFIGURATION.PROPERTY_DEFINITION.DEFINITION')
| (NOT (SIZEOF(QUERY ( sic <* QUERY ( pds <*
QUERY ( pdr <* USEDIN(pd,'PLANT_SPATIAL_CONFIGURATION.' +
'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') | (
'PLANT_SPATIAL_CONFIGURATION.PRODUCT_DEFINITION_SHAPE' IN
TYPEOF(pdr)) ) | (pds.used_representation.name =
'segment insulation characteristics') ) | (SIZEOF(

```

```

    QUERY ( it <* sic.used_representation.items |

(('PLANT_SPATIAL_CONFIGURATION.DESCRPTIVE_REPRESENTATION_ITEM'
  IN TYPEOF(it)) AND (it.name = 'boundaries')) )) <= 1) )) =
  1)) )) = 0)) )) = 0));
wr17: (SIZEOF(QUERY ( pds <* QUERY ( pd <* USEDIN(SELF,
  'PLANT_SPATIAL_CONFIGURATION.PROPERTY_DEFINITION.DEFINITION'
  | ('PLANT_SPATIAL_CONFIGURATION.PRODUCT_DEFINITION_SHAPE'
  IN TYPEOF(pd)) ) | (NOT (SIZEOF(QUERY ( sa <* USEDIN(pds,
  'PLANT_SPATIAL_CONFIGURATION.SHAPE_ASPECT.OF_SHAPE') |

('PLANT_SPATIAL_CONFIGURATION.PLANT_LINE_SEGMENT_TERMINATION'
  IN TYPEOF(sa)) )) = 2)) )) = 0);
END_ENTITY; -- plant_line_segment_definition

ENTITY plant_line_segment_termination
  SUBTYPE OF (shape_aspect);
  WHERE
    wr1: (((SELF.description = 'piping line segment termination') AND (
      'PLANT_SPATIAL_CONFIGURATION.PLANT_LINE_SEGMENT_DEFINITION'
      IN TYPEOF(SELF.of_shape.definition))) XOR ((SELF.description
      = 'piping line termination') AND

('PLANT_SPATIAL_CONFIGURATION.PRODUCT_DEFINITION_RELATIONSHIP'
  IN TYPEOF(SELF.of_shape.definition)) AND (
    'PLANT_SPATIAL_CONFIGURATION.PLANT_LINE_SEGMENT_DEFINITION'
    IN TYPEOF(SELF.of_shape.definition.
      related_product_definition)) AND (
      'PLANT_SPATIAL_CONFIGURATION.PLANT_LINE_DEFINITION' IN
      TYPEOF(SELF.of_shape.definition.relateing_product_definition))));
wr2: (SIZEOF(QUERY ( sar <* (USEDIN(SELF,
  'PLANT_SPATIAL_CONFIGURATION.' +
  'SHAPE_ASPECT_RELATIONSHIP.RELATING_SHAPE_ASPECT') + USEDIN(
  SELF,'PLANT_SPATIAL_CONFIGURATION.' +
  'SHAPE_ASPECT_RELATIONSHIP.RELATED_SHAPE_ASPECT')) | (NOT (
  SIZEOF(TYPEOF(sar) * [
    'PLANT_SPATIAL_CONFIGURATION.LINE_BRANCH_CONNECTION',
    'PLANT_SPATIAL_CONFIGURATION.LINE_PLANT_ITEM_CONNECTION',
    'PLANT_SPATIAL_CONFIGURATION.LINE_TERMINATION_CONNECTION'])
  = 1)) )) = 0);
wr3: SIZEOF (QUERY (sar <*
  USEDIN (SELF, 'PLANT_SPATIAL_CONFIGURATION.' +
  'SHAPE_ASPECT_RELATIONSHIP.RELATED_SHAPE_ASPECT') |
  SIZEOF (TYPEOF (sar) *
  ['PLANT_SPATIAL_CONFIGURATION.LINE_TERMINATION_CONNECTION',
  'PLANT_SPATIAL_CONFIGURATION.LINE_BRANCH_CONNECTION']) = 1)) +
  SIZEOF (QUERY (sar <*
  USEDIN (SELF, 'PLANT_SPATIAL_CONFIGURATION.' +
  'SHAPE_ASPECT_RELATIONSHIP.RELATING_SHAPE_ASPECT') |
  'PLANT_SPATIAL_CONFIGURATION.LINE_PLANT_ITEM_CONNECTION'
  IN TYPEOF (sar))) = 1;

```

END\_ENTITY; -- plant\_line\_segment\_termination

ENTITY plant\_spatial\_configuration\_change\_assignment  
 SUBTYPE OF (action\_assignment);  
 items : SET [1:?] OF change\_item;  
 WHERE  
 wr1: ('PLANT\_SPATIAL\_CONFIGURATION.CHANGE\_ACTION' IN TYPEOF(SELF.  
 assigned\_action));  
 END\_ENTITY; -- plant\_spatial\_configuration\_change\_assignment

ENTITY plant\_spatial\_configuration\_organization\_assignment  
 SUBTYPE OF (organization\_assignment);  
 items : SET [1:?] OF plant\_spatial\_configuration\_organization\_item;  
 WHERE  
 wr1: plant\_spatial\_configuration\_organization\_correlation(SELF);  
 END\_ENTITY; -- plant\_spatial\_configuration\_organization\_assignment

ENTITY plant\_spatial\_configuration\_person\_and\_organization\_assignment  
 SUBTYPE OF (person\_and\_organization\_assignment);  
 items : SET [1:?] OF  
 plant\_spatial\_configuration\_person\_and\_organization\_item;  
 WHERE  
 wr1: plant\_spatial\_configuration\_person\_and\_organization\_correlation(  
 SELF);  
 END\_ENTITY; -- plant\_spatial\_configuration\_person\_and\_organization\_assignment

ENTITY plant\_spatial\_configuration\_person\_assignment  
 SUBTYPE OF (person\_assignment);  
 items : SET [1:?] OF plant\_spatial\_configuration\_person\_item;  
 WHERE  
 wr1: plant\_spatial\_configuration\_person\_correlation(SELF);  
 END\_ENTITY; -- plant\_spatial\_configuration\_person\_assignment

ENTITY point  
 SUPERTYPE OF (ONEOF (cartesian\_point,point\_on\_curve,point\_on\_surface,  
 point\_replica,degenerate\_pcurve))  
 SUBTYPE OF (geometric\_representation\_item);  
 END\_ENTITY; -- point

ENTITY point\_on\_curve  
 SUBTYPE OF (point);  
 basis\_curve : curve;  
 point\_parameter : parameter\_value;  
 END\_ENTITY; -- point\_on\_curve

ENTITY point\_on\_surface  
 SUBTYPE OF (point);  
 basis\_surface : surface;  
 point\_parameter\_u : parameter\_value;  
 point\_parameter\_v : parameter\_value;  
 END\_ENTITY; -- point\_on\_surface

ENTITY point\_replica  
 SUBTYPE OF (point);  
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```

    parent_pt    : point;
    transformation : cartesian_transformation_operator;
WHERE
    wr1: (transformation.dim = parent_pt.dim);
    wr2: acyclic_point_replica(SELf,parent_pt);
END_ENTITY; -- point_replica

ENTITY poly_loop
    SUBTYPE OF (loop, geometric_representation_item);
    polygon : LIST [3:?] OF cartesian_point;
END_ENTITY; -- poly_loop

ENTITY polyline
    SUBTYPE OF (bounded_curve);
    points : LIST [2:?] OF cartesian_point;
END_ENTITY; -- polyline

ENTITY pre_defined_item;
    name : label;
END_ENTITY; -- pre_defined_item

ENTITY precision_qualifier;
    precision_value : INTEGER;
END_ENTITY; -- precision_qualifier

ENTITY presentation_layer_assignment;
    name      : label;
    description : text;
    assigned_items : SET [1:?] OF layered_item;
END_ENTITY; -- presentation_layer_assignment

ENTITY process_capability
    SUBTYPE OF (property_definition);
WHERE
    wr1: ('PLANT_SPATIAL_CONFIGURATION.PLANT' IN TYPEOF(SELF.definition\
        product_definition.formation.of_product));
    wr2: (SIZEOF(QUERY ( pdr <* USEDIN(SELF,
'PLANT_SPATIAL_CONFIGURATION.PROPERTY_DEFINITION_REPRESENTATION.'
    + 'DEFINITION') | ((pdr.used_representation.name =
'production capacity') AND (NOT (SIZEOF(QUERY ( it <* pdr.
    used_representation.items |
(('PLANT_SPATIAL_CONFIGURATION.DESCRPTIVE_REPRESENTATION_ITEM'
    IN TYPEOF(it)) AND (it.name = 'production type')) )) = 1)))) )
    = 0);
END_ENTITY; -- process_capability

ENTITY product;
    id      : identifier;
    name    : label;

```

```

    description      : OPTIONAL text;
    frame_of_reference : SET [1:?] OF product_context;
END_ENTITY; -- product

```

```

ENTITY product_context
  SUBTYPE OF (application_context_element);
  discipline_type : label;
END_ENTITY; -- product_context

```

```

ENTITY product_definition;
  id          : identifier;
  description  : OPTIONAL text;
  formation    : product_definition_formation;
  frame_of_reference : product_definition_context;
  DERIVE
    name : label := get_name_value(SELF);
  WHERE
    wr1: (SIZEOF(USEDIN(SELF,'PLANT_SPATIAL_CONFIGURATION.' +
      'NAME_ATTRIBUTE.NAMED_ITEM')) <= 1);
END_ENTITY; -- product_definition

```

```

ENTITY product_definition_context
  SUBTYPE OF (application_context_element);
  life_cycle_stage : label;
END_ENTITY; -- product_definition_context

```

```

ENTITY product_definition_formation;
  id          : identifier;
  description  : OPTIONAL text;
  of_product  : product;
  UNIQUE
    url : id, of_product;
END_ENTITY; -- product_definition_formation

```

```

ENTITY product_definition_formation_relationship;
  id          : identifier;
  name        : label;
  description  : OPTIONAL text;
  relating_product_definition_formation : product_definition_formation;
  related_product_definition_formation : product_definition_formation;
END_ENTITY; -- product_definition_formation_relationship

```

```

ENTITY product_definition_formation_with_specified_source
  SUBTYPE OF (product_definition_formation);
  make_or_buy : source;
END_ENTITY; -- product_definition_formation_with_specified_source

```

```

ENTITY product_definition_relationship;
  id          : identifier;
  name        : label;
  description  : OPTIONAL text;
  relating_product_definition : product_definition;
  related_product_definition : product_definition;
END_ENTITY; -- product_definition_relationship

```

```

ENTITY product_definition_shape
  SUBTYPE OF (property_definition);
  UNIQUE
    url : definition;
  WHERE
    wr1: (SIZEOF

```

```

(['PLANT_SPATIAL_CONFIGURATION.CHARACTERIZED_PRODUCT_DEFINITION',
  'PLANT_SPATIAL_CONFIGURATION.CHARACTERIZED_OBJECT'] *
  TYPEOF(SELf\property_definition.definition)) > 0);
END_ENTITY; -- product_definition_shape

```

```

ENTITY product_definition_substitute;
  description : OPTIONAL text;
  context_relationship : product_definition_relationship;
  substitute_definition : product_definition;
  DERIVE
    name : label := get_name_value(SELF);
  WHERE
    wr1: (context_relationship.related_product_definition :<>:
      substitute_definition);
    wr2: (SIZEOF(USEDIN(SELF,'PLANT_SPATIAL_CONFIGURATION.' +
      'NAME_ATTRIBUTE.NAMED_ITEM')) <= 1);
END_ENTITY; -- product_definition_substitute

```

```

ENTITY product_definition_usage
  SUPERTYPE OF (ONEOF (make_from_usage_option,assembly_component_usage))
  SUBTYPE OF (product_definition_relationship);
  WHERE
    wr1: acyclic_product_definition_relationship(SELF,[SELF\
      product_definition_relationship.related_product_definition],
      'PLANT_SPATIAL_CONFIGURATION.PRODUCT_DEFINITION_USAGE');
END_ENTITY; -- product_definition_usage

```

```

ENTITY product_definition_with_associated_documents
  SUBTYPE OF (product_definition);
  documentation_ids : SET [1:?] OF document;
END_ENTITY; -- product_definition_with_associated_documents

```

```

ENTITY product_material_composition_relationship
  SUBTYPE OF (product_definition_relationship);
  class : label;
  constituent_amount : SET [1:?] OF measure_with_unit;
  composition_basis : label;
  determination_method : text;
END_ENTITY; -- product_material_composition_relationship

```

```

ENTITY property_definition;
  name : label;
  description : OPTIONAL text;

```

```

    definition : characterized_definition;
DERIVE
    id : identifier := get_id_value(SELF);
WHERE
    wr1: (SIZEOF(USEDIN(SELF,'PLANT_SPATIAL_CONFIGURATION.' +
        'ID_ATTRIBUTE.IDENTIFIED_ITEM')) <= 1);
END_ENTITY; -- property_definition

ENTITY property_definition_relationship;
    name          : label;
    description    : text;
    relating_property_definition : property_definition;
    related_property_definition : property_definition;
END_ENTITY; -- property_definition_relationship

ENTITY property_definition_representation;
    definition      : represented_definition;
    used_representation : representation;
DERIVE
    description : text := get_description_value(SELF);
    name       : label := get_name_value(SELF);
WHERE
    wr1: (SIZEOF(USEDIN(SELF,'PLANT_SPATIAL_CONFIGURATION.' +
        'DESCRIPTION_ATTRIBUTE.DESCRIBED_ITEM')) <= 1);
    wr2: (SIZEOF(USEDIN(SELF,'PLANT_SPATIAL_CONFIGURATION.' +
        'NAME_ATTRIBUTE.NAMED_ITEM')) <= 1);
END_ENTITY; -- property_definition_representation

ENTITY purchase_assignment
    SUBTYPE OF (action_assignment);
    items : SET [1:?] OF purchase_item;
END_ENTITY; -- purchase_assignment

ENTITY qualified_representation_item
    SUBTYPE OF (representation_item);
    qualifiers : SET [1:?] OF value_qualifier;
WHERE
    wr1: (SIZEOF(QUERY ( temp <* qualifiers | (
        'PLANT_SPATIAL_CONFIGURATION.PRECISION_QUALIFIER' IN TYPEOF(
            temp))) ) < 2);
END_ENTITY; -- qualified_representation_item

ENTITY quasi_uniform_curve
    SUBTYPE OF (b_spline_curve);
END_ENTITY; -- quasi_uniform_curve

ENTITY quasi_uniform_surface
    SUBTYPE OF (b_spline_surface);
END_ENTITY; -- quasi_uniform_surface

ENTITY ratio_measure_with_unit
    SUBTYPE OF (measure_with_unit);
WHERE

```

```

    wr1: ('PLANT_SPATIAL_CONFIGURATION.RATIO_UNIT' IN
TYPEOF(SELf\measure_with_unit.
    unit_component));
END_ENTITY; -- ratio_measure_with_unit

```

```

ENTITY ratio_unit
SUBTYPE OF (named_unit);
WHERE
    wr1: ((SELf\named_unit.dimensions.length_exponent = 0) AND (SELf\
    named_unit.dimensions.mass_exponent = 0) AND (SELf\
    named_unit.dimensions.time_exponent = 0) AND (SELf\
    named_unit.dimensions.electric_current_exponent = 0) AND (
    SELf\named_unit.dimensions.
    thermodynamic_temperature_exponent = 0) AND (SELf\named_unit
    .dimensions.amount_of_substance_exponent = 0) AND (SELf\
    named_unit.dimensions.luminous_intensity_exponent = 0));
END_ENTITY; -- ratio_unit

```

```

ENTITY rational_b_spline_curve
SUBTYPE OF (b_spline_curve);
    weights_data : LIST [2:?] OF REAL;
DERIVE
    weights : ARRAY [0:100] OF REAL := list_to_array(weights_data,0,
    upper_index_on_control_points);
WHERE
    wr1: (SIZEOF(weights_data) = SIZEOF(SELf\b_spline_curve.
    control_points_list));
    wr2: curve_weights_positive(SELf);
END_ENTITY; -- rational_b_spline_curve

```

```

ENTITY rational_b_spline_surface
SUBTYPE OF (b_spline_surface);
    weights_data : LIST [2:?] OF LIST [2:?] OF REAL;
DERIVE
    weights : ARRAY [0:100] OF ARRAY [0:100] OF REAL :=
    make_array_of_array(weights_data,0,u_upper,0,v_upper);
WHERE
    wr1: ((SIZEOF(weights_data) = SIZEOF(SELf\b_spline_surface.
    control_points_list)) AND (SIZEOF(weights_data[1]) = SIZEOF(
    SELf\b_spline_surface.control_points_list[1])));
    wr2: surface_weights_positive(SELf);
END_ENTITY; -- rational_b_spline_surface

```

```

ENTITY rectangular_composite_surface
SUBTYPE OF (bounded_surface);
    segments : LIST [1:?] OF LIST [1:?] OF surface_patch;
DERIVE
    n_u : INTEGER := SIZEOF(segments);
    n_v : INTEGER := SIZEOF(segments[1]);
WHERE
    wr1: (SIZEOF(QUERY ( s < * segments | (n_v <> SIZEOF(s)) )) = 0);

```

```

    wr2: constraints_rectangular_composite_surface(SELF);
END_ENTITY; -- rectangular_composite_surface

```

```

ENTITY rectangular_pyramid
  SUBTYPE OF (geometric_representation_item);
  position : axis2_placement_3d;
  xlength  : positive_length_measure;
  ylength  : positive_length_measure;
  height   : positive_length_measure;
END_ENTITY; -- rectangular_pyramid

```

```

ENTITY rectangular_trimmed_surface
  SUBTYPE OF (bounded_surface);
  basis_surface : surface;
  u1            : parameter_value;
  u2            : parameter_value;
  v1            : parameter_value;
  v2            : parameter_value;
  usense        : BOOLEAN;
  vsense        : BOOLEAN;
  WHERE
    wr1: (u1 <> u2);
    wr2: (v1 <> v2);
    wr3: (((('PLANT_SPATIAL_CONFIGURATION.ELEMENTARY_SURFACE' IN
      TYPEOF(basis_surface))
      AND (NOT ('PLANT_SPATIAL_CONFIGURATION.PLANE' IN
      TYPEOF(basis_surface))))
      OR ('PLANT_SPATIAL_CONFIGURATION.SURFACE_OF_REVOLUTION' IN
      TYPEOF(basis_surface)) OR (usense = (u2 > u1)))));
    wr4: (((('PLANT_SPATIAL_CONFIGURATION.SPHERICAL_SURFACE' IN
      TYPEOF(basis_surface))
      OR ('PLANT_SPATIAL_CONFIGURATION.TOROIDAL_SURFACE' IN TYPEOF(
      basis_surface)) OR (vsense = (v2 > v1)))));
END_ENTITY; -- rectangular_trimmed_surface

```

```

ENTITY reducer_fitting_class
  SUBTYPE OF (group);
  WHERE
    wr1: (SIZEOF(QUERY ( aca <* QUERY ( ca <* USEDIN(SELF,
      'PLANT_SPATIAL_CONFIGURATION.CLASSIFICATION_ASSIGNMENT.' +
      'ASSIGNED_CLASS') |
      ('PLANT_SPATIAL_CONFIGURATION.APPLIED_CLASSIFICATION_ASSIGNMENT'
      IN TYPEOF(ca)) ) | (NOT (SIZEOF(QUERY ( it <* aca.items | (
      NOT (
      'PLANT_SPATIAL_CONFIGURATION.PIPING_COMPONENT_DEFINITION' IN
      TYPEOF(it))) )) = 0)) )) = 0);
    wr2: (SIZEOF(QUERY ( aca <* QUERY ( ca <* USEDIN(SELF,
      'PLANT_SPATIAL_CONFIGURATION.CLASSIFICATION_ASSIGNMENT.' +
      'ASSIGNED_CLASS') |
      ('PLANT_SPATIAL_CONFIGURATION.APPLIED_CLASSIFICATION_ASSIGNMENT'
      IN TYPEOF(ca)) ) | (NOT (SIZEOF(QUERY ( pcd <*
      QUERY ( it <* aca.items | (

```

```

    'PLANT_SPATIAL_CONFIGURATION.PIPING_COMPONENT_DEFINITION' IN
    TYPEOF(it)) ) | (NOT (SIZEOF(QUERY ( aca1 <* USEDIN(pcd.
    formation.of_product,'PLANT_SPATIAL_CONFIGURATION.' +
    'APPLIED_CLASSIFICATION_ASSIGNMENT.ITEMS') | class_in_tree(
    aca1.assigned_class,'reducer') )) = 1)) )) = 0)) )) = 0);
END_ENTITY; -- reducer_fitting_class

```

```

ENTITY reference_geometry
  SUBTYPE OF (derived_shape_aspect);
  WHERE
    wr1: (SIZEOF(QUERY ( pd <* USEDIN(SELF,
    'PLANT_SPATIAL_CONFIGURATION.' +
    'PROPERTY_DEFINITION.DEFINITION') | (NOT (SIZEOF(USEDIN(pd,
    'PLANT_SPATIAL_CONFIGURATION.' +
    'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION')) >= 1)) ))
    = 0);
END_ENTITY; -- reference_geometry

```

```

ENTITY reinforcing_component_definition
  SUBTYPE OF (product_definition);
END_ENTITY; -- reinforcing_component_definition

```

```

ENTITY reparametrised_composite_curve_segment
  SUBTYPE OF (composite_curve_segment);
  param_length : parameter_value;
  WHERE
    wr1: (param_length > 0);
END_ENTITY; -- reparametrised_composite_curve_segment

```

```

ENTITY representation;
  name          : label;
  items         : SET [1:?] OF representation_item;
  context_of_items : representation_context;
  DERIVE
    id          : identifier := get_id_value(SELF);
    description : text := get_description_value(SELF);
  WHERE
    wr1: (SIZEOF(USEDIN(SELF,'PLANT_SPATIAL_CONFIGURATION.' +
    'ID_ATTRIBUTE.IDENTIFIED_ITEM')) <= 1);
    wr2: (SIZEOF(USEDIN(SELF,'PLANT_SPATIAL_CONFIGURATION.' +
    'DESCRIPTION_ATTRIBUTE.DESCRIBED_ITEM')) <= 1);
END_ENTITY; -- representation

```

```

ENTITY representation_context;
  context_identifier : identifier;
  context_type      : text;
  INVERSE
    representations_in_context : SET [1:?] OF representation FOR
    context_of_items;
END_ENTITY; -- representation_context

```

```

ENTITY representation_item;
    name : label;
    WHERE
        wr1: (SIZEOF(using_representations(SELF)) > 0);
END_ENTITY; -- representation_item

```

```

ENTITY representation_item_relationship;
    name : label;
    description : OPTIONAL text;
    relating_representation_item : representation_item;
    related_representation_item : representation_item;
END_ENTITY; -- representation_item_relationship

```

```

ENTITY representation_map;
    mapping_origin : representation_item;
    mapped_representation : representation;
    INVERSE
        map_usage : SET [1:?] OF mapped_item FOR mapping_source;
    WHERE
        wr1: item_in_context(SELF.mapping_origin,SELF.mapped_representation.
            context_of_items);
END_ENTITY; -- representation_map

```

```

ENTITY required_material_property
    SUBTYPE OF (material_property);
    WHERE
        wr1: ((SIZEOF(TYPEOF(SELF\property_definition.definition) * [
            'PLANT_SPATIAL_CONFIGURATION.PLANT_ITEM_CONNECTOR',
            'PLANT_SPATIAL_CONFIGURATION.' +
            'EXTERNALLY_DEFINED_PLANT_ITEM_DEFINITION']) = 1) OR ((
            'PLANT_SPATIAL_CONFIGURATION.PRODUCT_DEFINITION' IN TYPEOF(
            SELF.definition)) AND (SIZEOF(QUERY ( pc <* SELF\
            property_definition.definition\product_definition.formation.
            of_product.frame_of_reference | (pc.discipline_type =
            'process plant') )) = 1)));
        wr2: (SIZEOF(QUERY ( ra <* QUERY ( pdr <* USEDIN(SELF,
            'PLANT_SPATIAL_CONFIGURATION.' +
            'PROPERTY_DEFINITION_RELATIONSHIP.RELATED_PROPERTY_DEFINITION'
            | (pdr.name = 'requirement allocation') ) | (
            'PLANT_SPATIAL_CONFIGURATION.MATERIAL_PROPERTY' IN TYPEOF(ra
            .relating_property_definition)) )) >= 1);
END_ENTITY; -- required_material_property

```

```

ENTITY reserved_space
    SUBTYPE OF (shape_aspect);
    WHERE
        wr1: (SELF\shape_aspect.of_shape\property_definition.definition\
            product_definition.frame_of_reference\
            application_context_element.name = 'physical occurrence');
END_ENTITY; -- reserved_space

```

```

ENTITY revolved_area_solid
    SUBTYPE OF (swept_area_solid);
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```

```

    axis : axis1_placement;
    angle : plane_angle_measure;
    DERIVE
    axis_line : line := dummy_gri || curve() || line(axis.location,
        dummy_gri || vector(axis.z,1));
    END_ENTITY; -- revolved_area_solid

```

```

ENTITY revolved_face_solid
    SUBTYPE OF (swept_face_solid);
    axis : axis1_placement;
    angle : plane_angle_measure;
    DERIVE
    axis_line : line := dummy_gri || curve() || line(axis.location,
        dummy_gri || vector(axis.z,1));
    END_ENTITY; -- revolved_face_solid

```

```

ENTITY right_angular_wedge
    SUBTYPE OF (geometric_representation_item);
    position : axis2_placement_3d;
    x      : positive_length_measure;
    y      : positive_length_measure;
    z      : positive_length_measure;
    ltx    : length_measure;
    WHERE
    wr1: ((0 <= ltx) AND (ltx < x));
    END_ENTITY; -- right_angular_wedge

```

```

ENTITY right_circular_cone
    SUBTYPE OF (geometric_representation_item);
    position : axis1_placement;
    height   : positive_length_measure;
    radius   : length_measure;
    semi_angle : plane_angle_measure;
    WHERE
    wr1: (radius >= 0);
    END_ENTITY; -- right_circular_cone

```

```

ENTITY right_circular_cylinder
    SUBTYPE OF (geometric_representation_item);
    position : axis1_placement;
    height   : positive_length_measure;
    radius   : positive_length_measure;
    END_ENTITY; -- right_circular_cylinder

```

```

ENTITY role_association;
    role      : object_role;
    item_with_role : role_select;
    END_ENTITY; -- role_association

```

```

ENTITY seam_curve
    SUBTYPE OF (surface_curve);

```

```

WHERE
  wr1: (SIZEOF(SELF\surface_curve.associated_geometry) = 2);
  wr2: (associated_surface(SELF\surface_curve.associated_geometry[1])
        = associated_surface(SELF\surface_curve.associated_geometry[
          2]));
  wr3: ('PLANT_SPATIAL_CONFIGURATION.PCURVE' IN TYPEOF(SELF\surface_curve.
    associated_geometry[1]));
  wr4: ('PLANT_SPATIAL_CONFIGURATION.PCURVE' IN TYPEOF(SELF\surface_curve.
    associated_geometry[2]));
END_ENTITY; -- seam_curve

```

```

ENTITY shape_aspect;
  name          : label;
  description    : OPTIONAL text;
  of_shape      : product_definition_shape;
  product_definitional : LOGICAL;
DERIVE
  id : identifier := get_id_value(SELF);
WHERE
  wr1: (SIZEOF(USEDIN(SELF,'PLANT_SPATIAL_CONFIGURATION.' +
    'ID_ATTRIBUTE.IDENTIFIED_ITEM')) <= 1);
END_ENTITY; -- shape_aspect

```

```

ENTITY shape_aspect_deriving_relationship
  SUBTYPE OF (shape_aspect_relationship);
WHERE
  WR1: 'PLANT_SPATIAL_CONFIGURATION.DERIVED_SHAPE_ASPECT' IN TYPEOF
    (SELF\SHAPE_ASPECT_RELATIONSHIP.RELATING_SHAPE_ASPECT);
END_ENTITY;

```

```

ENTITY shape_aspect_relationship;
  name          : label;
  description    : OPTIONAL text;
  relating_shape_aspect : shape_aspect;
  related_shape_aspect : shape_aspect;
DERIVE
  id : identifier := get_id_value(SELF);
WHERE
  wr1: (SIZEOF(USEDIN(SELF,'PLANT_SPATIAL_CONFIGURATION.' +
    'ID_ATTRIBUTE.IDENTIFIED_ITEM')) <= 1);
END_ENTITY; -- shape_aspect_relationship

```

```

ENTITY shape_definition_representation
  SUBTYPE OF (property_definition_representation);
WHERE
  wr1: (('PLANT_SPATIAL_CONFIGURATION.PRODUCT_DEFINITION_SHAPE'
    IN TYPEOF(SELF.definition)) OR (
    'PLANT_SPATIAL_CONFIGURATION.SHAPE_DEFINITION' IN
    TYPEOF(SELF.definition.definition)));
  wr2: ('PLANT_SPATIAL_CONFIGURATION.SHAPE_REPRESENTATION'
    IN TYPEOF(SELF.used_representation));
END_ENTITY; -- shape_definition_representation

```

```

ENTITY shape_dimension_representation
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```

```

SUBTYPE OF (shape_representation);
WHERE
  wr1: (SIZEOF(QUERY ( temp <* SELF\representation.items | (NOT (
    'PLANT_SPATIAL_CONFIGURATION.MEASURE_REPRESENTATION_ITEM' IN
    TYPEOF(temp)))) ) = 0);
  wr2: (SIZEOF(SELF\representation.items) <= 3);
  wr3: (SIZEOF(QUERY ( pos_mri <* QUERY ( real_mri <* SELF\
    representation.items | ('REAL' IN TYPEOF(real_mri\
    measure_with_unit.value_component)) ) | (NOT (pos_mri\
    measure_with_unit.value_component > 0)) ) ) = 0);
END_ENTITY; -- shape_dimension_representation

ENTITY shape_representation
  SUBTYPE OF (representation);
END_ENTITY; -- shape_representation

ENTITY shell_based_wireframe_model
  SUBTYPE OF (geometric_representation_item);
  sbwm_boundary : SET [1:?] OF shell;
WHERE
  wr1: constraints_geometry_shell_based_wireframe_model(SELF);
END_ENTITY; -- shell_based_wireframe_model

ENTITY si_unit
  SUBTYPE OF (named_unit);
  prefix : OPTIONAL si_prefix;
  name : si_unit_name;
  DERIVE
    SELF\named_unit.dimensions : dimensional_exponents :=
      dimensions_for_si_unit(name);
END_ENTITY; -- si_unit

ENTITY site
  SUBTYPE OF (characterized_object, property_definition);
WHERE
  wr1: ('PLANT_SPATIAL_CONFIGURATION.PLANT' IN TYPEOF(SELF\
    property_definition.definition\product_definition.formation.
    of_product));
END_ENTITY; -- site

ENTITY site_building
  SUBTYPE OF (property_definition);
WHERE
  wr1: ('PLANT_SPATIAL_CONFIGURATION.SITE' IN TYPEOF(SELF.definition));
  wr2: (SIZEOF(QUERY ( pdr <* USEDIN(SELF,
    'PLANT_SPATIAL_CONFIGURATION.' +
    'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') | ((pdr.
    used_representation.name = 'building number') AND (SIZEOF(
    QUERY ( it <* pdr.used_representation.items |

('PLANT_SPATIAL_CONFIGURATION.DESCRPTIVE_REPRESENTATION_ITEM'

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```

    IN TYPEOF(it)) )) = 1)) )) = 1);
wr3: (SIZEOF(QUERY ( pdr <* USEDIN(SELf,
  'PLANT_SPATIAL_CONFIGURATION.' +
  'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') | (SIZEOF(
  QUERY ( it <* pdr.used_representation.items | ((SIZEOF([
  'PLANT_SPATIAL_CONFIGURATION.AXIS2_PLACEMENT_2D',
  'PLANT_SPATIAL_CONFIGURATION.AXIS2_PLACEMENT_3D'] * TYPEOF(
  it)) = 1) AND (it.name = 'building orientation') AND (it.
  location.name = 'building location')) )) = 1) )) <= 1);
END_ENTITY; -- site_building

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```

ENTITY site_feature
  SUBTYPE OF (property_definition);
  WHERE
    wr1: ('PLANT_SPATIAL_CONFIGURATION.SITE' IN TYPEOF(SELF.definition));
    wr2: (SIZEOF(USEDIN(SELF,'PLANT_SPATIAL_CONFIGURATION.' +
  'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION')) = 3);
    wr3: (SIZEOF(QUERY ( pdr <* USEDIN(SELF,
  'PLANT_SPATIAL_CONFIGURATION.' +
  'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') | (SIZEOF(
  QUERY ( it <* pdr.used_representation.items |
  (('PLANT_SPATIAL_CONFIGURATION.DESCRPTIVE_REPRESENTATION_ITEM'
    IN TYPEOF(it)) AND (it.name = 'site feature type')) )) = 1) ))
    = 1);
    wr4: (SIZEOF(QUERY ( pdr <* USEDIN(SELF,
  'PLANT_SPATIAL_CONFIGURATION.' +
  'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') | (SIZEOF(
  QUERY ( it <* pdr.used_representation.items | ((SIZEOF([
  'PLANT_SPATIAL_CONFIGURATION.AXIS2_PLACEMENT_2D',
  'PLANT_SPATIAL_CONFIGURATION.AXIS2_PLACEMENT_3D'] * TYPEOF(
  it)) = 1) AND (it.name = 'feature orientation') AND (it.
  location.name = 'feature location')) )) = 1) )) = 1);
    wr5: (SIZEOF(QUERY ( pdr <* USEDIN(SELF,
  'PLANT_SPATIAL_CONFIGURATION.' +
  'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') | (SIZEOF(
  QUERY ( it <* pdr.used_representation.items |
  (('PLANT_SPATIAL_CONFIGURATION.DESCRPTIVE_REPRESENTATION_ITEM'
    IN TYPEOF(pdr.used_representation)) AND (it.name =
    'origin type') AND (it.description IN ['man made','natural'])) ))
    = 1) )) = 1);
END_ENTITY; -- site_feature

```

```

ENTITY site_representation
  SUBTYPE OF (shape_representation);
  WHERE
    wr1: (SIZEOF(QUERY ( pdr <* USEDIN(SELF,
  'PLANT_SPATIAL_CONFIGURATION.' +
  'PROPERTY_DEFINITION_REPRESENTATION.USED_REPRESENTATION') |
  (NOT ('PLANT_SPATIAL_CONFIGURATION.SITE' IN TYPEOF(pdr.
  definition.definition))) )) = 0);
    wr2: (SIZEOF(QUERY ( item <* SELF.items | (NOT (SIZEOF([
  'PLANT_SPATIAL_CONFIGURATION.CONNECTED_FACE_SET',

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    'PLANT_SPATIAL_CONFIGURATION.GEOMETRIC_CURVE_SET'] * TYPEOF(
    item)) = 1)) )) = 1);
wr3: (SIZEOF(QUERY ( cfs <* QUERY ( item <* SELF.items | (
    'PLANT_SPATIAL_CONFIGURATION.CONNECTED_FACE_SET' IN TYPEOF(
    item))) ) | (NOT (SIZEOF(QUERY ( fcs <* cfs\
    connected_face_set.cfs_faces | (NOT (SIZEOF(QUERY ( bnds <*
    fcs.bounds | (NOT ('PLANT_SPATIAL_CONFIGURATION.POLY_LOOP'
    IN TYPEOF(bnds.bound))) )) = 0)) )) = 0)) )) = 0);
wr4: (SIZEOF(QUERY ( cfs <* QUERY ( item <* SELF.items | (
    'PLANT_SPATIAL_CONFIGURATION.CONNECTED_FACE_SET' IN TYPEOF(
    item))) ) | (NOT (SIZEOF(QUERY ( fcs <* cfs\
    connected_face_set.cfs_faces | (NOT (SIZEOF(QUERY ( bnds <*
    fcs.bounds | (NOT (SIZEOF(bnds.bound\poly_loop.polygon) = 3)) ))
    = 0)) )) = 0)) )) = 0);
wr5: (SIZEOF(QUERY ( gcs <* QUERY ( item <* SELF.items | (
    'PLANT_SPATIAL_CONFIGURATION.GEOMETRIC_CURVE_SET' IN TYPEOF(
    item))) ) | (NOT (SIZEOF(QUERY ( el <* gcs\geometric_set.
    elements | (NOT (SIZEOF([
    'PLANT_SPATIAL_CONFIGURATION.CARTESIAN_POINT',
    'PLANT_SPATIAL_CONFIGURATION.POLYLINE'] * TYPEOF(el)) = 1)) ))
    = 0)) )) = 0);
wr6: (SIZEOF(QUERY ( gcs <* QUERY ( item <* SELF.items | (
    'PLANT_SPATIAL_CONFIGURATION.GEOMETRIC_CURVE_SET' IN TYPEOF(
    item))) ) | (NOT (SIZEOF(QUERY ( el <* gcs\geometric_set.
    elements | ('PLANT_SPATIAL_CONFIGURATION.CARTESIAN_POINT' IN
    TYPEOF(el)) )) >= 1)) )) = 0);
wr7: (SIZEOF(QUERY ( gcs <* QUERY ( item <* SELF.items | (
    'PLANT_SPATIAL_CONFIGURATION.GEOMETRIC_CURVE_SET' IN TYPEOF(
    item))) ) | (NOT (SIZEOF(QUERY ( pline <* QUERY ( el <* gcs\
    geometric_set.elements | (
    'PLANT_SPATIAL_CONFIGURATION.POLYLINE' IN TYPEOF(el)) ) | (
    NOT (SIZEOF(QUERY ( pline_pt <* pline\polyline.points | (
    NOT (pline_pt IN gcs\geometric_set.elements)) )) = 0)) )) =
    0)) )) = 0);
END_ENTITY; -- site_representation

```

ENTITY sited\_plant

SUBTYPE OF (property\_definition);

WHERE

wr1: ('PLANT\_SPATIAL\_CONFIGURATION.PRODUCT\_DEFINITION' IN TYPEOF(
 SELF.definition));

wr2: (SELF.definition.frame\_of\_reference.name =
 'physical occurrence');

END\_ENTITY; -- sited\_plant

ENTITY solid\_angle\_measure\_with\_unit

SUBTYPE OF (measure\_with\_unit);

WHERE

wr1: ('PLANT\_SPATIAL\_CONFIGURATION.SOLID\_ANGLE\_UNIT' IN TYPEOF(SELF\
 measure\_with\_unit.unit\_component));

END\_ENTITY; -- solid\_angle\_measure\_with\_unit

```

ENTITY solid_angle_unit
  SUBTYPE OF (named_unit);
  WHERE
    wr1: ((SELF\named_unit.dimensions.length_exponent = 0) AND (SELF\
      named_unit.dimensions.mass_exponent = 0) AND (SELF\
      named_unit.dimensions.time_exponent = 0) AND (SELF\
      named_unit.dimensions.electric_current_exponent = 0) AND (
      SELF\named_unit.dimensions.
      thermodynamic_temperature_exponent = 0) AND (SELF\named_unit
      .dimensions.amount_of_substance_exponent = 0) AND (SELF\
      named_unit.dimensions.luminous_intensity_exponent = 0));
END_ENTITY; -- solid_angle_unit

ENTITY solid_model
  SUPERTYPE OF (ONEOF (csg_solid,manifold_solid_brep,swept_face_solid,
    swept_area_solid))
  SUBTYPE OF (geometric_representation_item);
END_ENTITY; -- solid_model

ENTITY spacer_fitting_class
  SUBTYPE OF (group);
  WHERE
    wr1: (SIZEOF(QUERY ( aca <* QUERY ( ca <* USEDIN(SELF,
      'PLANT_SPATIAL_CONFIGURATION.CLASSIFICATION_ASSIGNMENT.' +
      'ASSIGNED_CLASS') |
      ('PLANT_SPATIAL_CONFIGURATION.APPLIED_CLASSIFICATION_ASSIGNMENT'
      IN TYPEOF(ca)) ) | (NOT (SIZEOF(QUERY ( it <* aca.items | (
      NOT (
      'PLANT_SPATIAL_CONFIGURATION.PIPING_COMPONENT_DEFINITION' IN
      TYPEOF(it))) )) = 0)) )) = 0);
    wr2: (SIZEOF(QUERY ( aca <* QUERY ( ca <* USEDIN(SELF,
      'PLANT_SPATIAL_CONFIGURATION.CLASSIFICATION_ASSIGNMENT.' +
      'ASSIGNED_CLASS') |
      ('PLANT_SPATIAL_CONFIGURATION.APPLIED_CLASSIFICATION_ASSIGNMENT'
      IN TYPEOF(ca)) ) | (NOT (SIZEOF(QUERY ( pcd <*
      QUERY ( it <* aca.items | (
      'PLANT_SPATIAL_CONFIGURATION.PIPING_COMPONENT_DEFINITION' IN
      TYPEOF(it)) ) | (NOT (SIZEOF(QUERY ( aca1 <* USEDIN(pcd.
      formation.of_product,'PLANT_SPATIAL_CONFIGURATION.' +
      'APPLIED_CLASSIFICATION_ASSIGNMENT.ITEMS') | class_in_tree(
      aca1.assigned_class,'spacer') )) = 1)) )) = 0)) )) = 0);
END_ENTITY; -- spacer_fitting_class

ENTITY specialty_item_class
  SUBTYPE OF (group);
END_ENTITY; -- specialty_item_class

ENTITY sphere
  SUBTYPE OF (geometric_representation_item);
  radius : positive_length_measure;
  centre : point;
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END\_ENTITY; -- sphere

ENTITY spherical\_surface  
 SUBTYPE OF (elementary\_surface);  
     radius : positive\_length\_measure;  
 END\_ENTITY; -- spherical\_surface

ENTITY stream\_design\_case  
 SUBTYPE OF (property\_definition, characterized\_object);  
 WHERE  
     wr1 : (SIZEOF(QUERY ( pd <\* USEDIN(SELF,  
         'PLANT\_SPATIAL\_CONFIGURATION.' +  
         'PROPERTY\_DEFINITION.DEFINITION') | (  
         'PLANT\_SPATIAL\_CONFIGURATION.STREAM\_PHASE' IN TYPEOF(pd)) ))  
         >= 1);  
     wr2 : (SIZEOF(QUERY ( pdr <\* USEDIN(SELF,  
         'PLANT\_SPATIAL\_CONFIGURATION.' +  
         'PROPERTY\_DEFINITION\_REPRESENTATION.DEFINITION') | (pdr.  
         used\_representation.name = 'stream flow characteristics') ))  
         = 1);  
     wr3 : (SIZEOF(QUERY ( sfc <\* QUERY ( pdr <\* USEDIN(SELF,  
         'PLANT\_SPATIAL\_CONFIGURATION.' +  
         'PROPERTY\_DEFINITION\_REPRESENTATION.DEFINITION') | (pdr.  
         used\_representation.name = 'stream flow characteristics') )  
         | (NOT (SIZEOF(sfc.used\_representation.items) >= 2)) )) =  
         0);  
     wr4 : (SIZEOF(QUERY ( sfc <\* QUERY ( pdr <\* USEDIN(SELF,  
         'PLANT\_SPATIAL\_CONFIGURATION.' +  
         'PROPERTY\_DEFINITION\_REPRESENTATION.DEFINITION') | (pdr.  
         used\_representation.name = 'stream flow characteristics') )  
         | (NOT ((1 <= SIZEOF(QUERY ( it <\* sfc.used\_representation  
             .items | ((  
             'PLANT\_SPATIAL\_CONFIGURATION.MEASURE\_REPRESENTATION\_ITEM'  
             IN TYPEOF(it)) AND (it.name IN ['flow rate',  
             'minimum flow rate','maximum flow rate'])) )) AND (SIZEOF(  
             QUERY ( it <\* sfc.used\_representation.items | ((  
             'PLANT\_SPATIAL\_CONFIGURATION.MEASURE\_REPRESENTATION\_ITEM'  
             IN TYPEOF(it)) AND (it.name IN ['flow rate',  
             'minimum flow rate','maximum flow rate'])) )) <= 2))) )) =  
         0);  
     wr5 : (SIZEOF(QUERY ( sfc <\* QUERY ( pdr <\* USEDIN(SELF,  
         'PLANT\_SPATIAL\_CONFIGURATION.' +  
         'PROPERTY\_DEFINITION\_REPRESENTATION.DEFINITION') | (pdr.  
         used\_representation.name = 'stream flow characteristics') )  
         | (NOT (SIZEOF(QUERY ( it <\* sfc.used\_representation.items  
             | ((  
             'PLANT\_SPATIAL\_CONFIGURATION.MEASURE\_REPRESENTATION\_ITEM'  
             IN TYPEOF(it)) AND (it.name = 'flow rate')) )) <= 1)) )) =  
         0);  
     wr6 : (SIZEOF(QUERY ( sfc <\* QUERY ( pdr <\* USEDIN(SELF,  
         'PLANT\_SPATIAL\_CONFIGURATION.' +

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'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') | (pdr.
used_representation.name = 'stream flow characteristics') )
| (NOT (SIZEOF(QUERY ( it <* sfc.used_representation.items
| ((
'PLANT_SPATIAL_CONFIGURATION.MEASURE_REPRESENTATION_ITEM'
IN TYPEOF(it)) AND (it.name = 'minimum flow rate')) )) <= 1)) ))
= 0);
wr7 : (SIZEOF(QUERY ( sfc <* QUERY ( pdr <* USEDIN(SELF,
'PLANT_SPATIAL_CONFIGURATION.' +
'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') | (pdr.
used_representation.name = 'stream flow characteristics') )
| (NOT (SIZEOF(QUERY ( it <* sfc.used_representation.items
| ((
'PLANT_SPATIAL_CONFIGURATION.MEASURE_REPRESENTATION_ITEM'
IN TYPEOF(it)) AND (it.name = 'maximum flow rate')) )) <= 1)) ))
= 0);
wr8 : (SIZEOF(QUERY ( sfc <* QUERY ( pdr <* USEDIN(SELF,
'PLANT_SPATIAL_CONFIGURATION.' +
'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') | (pdr.
used_representation.name = 'stream flow characteristics') )
| (NOT ((1 <= SIZEOF(QUERY ( it <* sfc.used_representation
.items | ((
'PLANT_SPATIAL_CONFIGURATION.MEASURE_REPRESENTATION_ITEM'
IN TYPEOF(it)) AND (it.name IN ['pressure',
'minimum pressure','maximum pressure'])) ))) AND (SIZEOF(
QUERY ( it <* sfc.used_representation.items | ((
'PLANT_SPATIAL_CONFIGURATION.MEASURE_REPRESENTATION_ITEM'
IN TYPEOF(it)) AND (it.name IN ['pressure',
'minimum pressure','maximum pressure'])) )) <= 2))) )) = 0);
wr9 : (SIZEOF(QUERY ( sfc <* QUERY ( pdr <* USEDIN(SELF,
'PLANT_SPATIAL_CONFIGURATION.' +
'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') | (pdr.
used_representation.name = 'stream flow characteristics') )
| (NOT (SIZEOF(QUERY ( it <* sfc.used_representation.items
| ((
'PLANT_SPATIAL_CONFIGURATION.MEASURE_REPRESENTATION_ITEM'
IN TYPEOF(it)) AND (it.name = 'pressure')) )) <= 1)) )) = 0);
wr10: (SIZEOF(QUERY ( sfc <* QUERY ( pdr <* USEDIN(SELF,
'PLANT_SPATIAL_CONFIGURATION.' +
'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') | (pdr.
used_representation.name = 'stream flow characteristics') )
| (NOT (SIZEOF(QUERY ( it <* sfc.used_representation.items
| ((
'PLANT_SPATIAL_CONFIGURATION.MEASURE_REPRESENTATION_ITEM'
IN TYPEOF(it)) AND (it.name = 'minimum pressure')) )) <= 1)) ))
= 0);
wr11: (SIZEOF(QUERY ( sfc <* QUERY ( pdr <* USEDIN(SELF,
'PLANT_SPATIAL_CONFIGURATION.' +
'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') | (pdr.
used_representation.name = 'stream flow characteristics') )
| (NOT (SIZEOF(QUERY ( it <* sfc.used_representation.items
| ((
'PLANT_SPATIAL_CONFIGURATION.MEASURE_REPRESENTATION_ITEM'
IN TYPEOF(it)) AND (it.name = 'maximum pressure')) )) <= 1)) ))

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= 0);
wr12: (SIZEOF(QUERY ( sfc <* QUERY ( pdr <* USEDIN(SELF,
'PLANT_SPATIAL_CONFIGURATION.' +
'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') | (pdr.
used_representation.name = 'stream flow characteristics') ) |
(NOT (SIZEOF(QUERY ( it <* sfc.used_representation.items |

(('PLANT_SPATIAL_CONFIGURATION.DESCRPTIVE_REPRESENTATION_ITEM'
IN TYPEOF(it)) AND (it.name = 'stream data reference')) ))
<= 1)) )) = 0);
wr13: ((NOT (SIZEOF(QUERY ( pdr <* USEDIN(SELF,
'PLANT_SPATIAL_CONFIGURATION.' +

'PROPERTY_DEFINITION_RELATIONSHIP.RELATING_PROPERTY_DEFINITION')
| (pdr.related_property_definition.name =
'service characteristics') )) >= 1)) OR (SIZEOF(
QUERY ( sc <* QUERY ( pdr <* USEDIN(SELF,
'PLANT_SPATIAL_CONFIGURATION.' +

'PROPERTY_DEFINITION_RELATIONSHIP.RELATING_PROPERTY_DEFINITION')
| (pdr.related_property_definition.name =
'service characteristics') ) | (NOT (SIZEOF(QUERY ( pdr <*
USEDIN(sc.related_property_definition,
'PLANT_SPATIAL_CONFIGURATION.' +
'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') | (pdr.
used_representation.name =
'service operating characteristics') )) = 1)) )) = 0));
wr14: ((NOT (SIZEOF(QUERY ( pdr <* USEDIN(SELF,
'PLANT_SPATIAL_CONFIGURATION.' +

'PROPERTY_DEFINITION_RELATIONSHIP.RELATING_PROPERTY_DEFINITION')
| (pdr.related_property_definition.name =
'service characteristics') )) >= 1)) OR (SIZEOF(
QUERY ( sc <* QUERY ( pdr <* USEDIN(SELF,
'PLANT_SPATIAL_CONFIGURATION.' +

'PROPERTY_DEFINITION_RELATIONSHIP.RELATING_PROPERTY_DEFINITION')
| (pdr.related_property_definition.name =
'service characteristics') ) | (NOT (SIZEOF(QUERY ( soc <*
QUERY ( pdr <* USEDIN(sc.related_property_definition,
'PLANT_SPATIAL_CONFIGURATION.' +
'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') | (pdr.
used_representation.name =
'service operating characteristics') ) | (NOT (SIZEOF(soc.
used_representation.items) >= 3)) )) = 0)) )) = 0));
wr15: ((NOT (SIZEOF(QUERY ( pdr <* USEDIN(SELF,
'PLANT_SPATIAL_CONFIGURATION.' +

'PROPERTY_DEFINITION_RELATIONSHIP.RELATING_PROPERTY_DEFINITION')
| (pdr.related_property_definition.name =
'service characteristics') )) >= 1)) OR (SIZEOF(

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QUERY ( sc <* QUERY ( pdr <* USEDIN(SELF,
'PLANT_SPATIAL_CONFIGURATION.' +

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'PROPERTY_DEFINITION_RELATIONSHIP.RELATING_PROPERTY_DEFINITION')
| (pdr.related_property_definition.name =
'service characteristics') ) | (NOT (SIZEOF(QUERY ( soc <*
QUERY ( pdr <* USEDIN(sc.related_property_definition,
'PLANT_SPATIAL_CONFIGURATION.' +
'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') | (pdr.
used_representation.name =
'service operating characteristics') ) | ((1 <= SIZEOF(
QUERY ( it <* soc.used_representation.items | ((SIZEOF(
TYPEOF(it) * [
'PLANT_SPATIAL_CONFIGURATION.MEASURE_REPRESENTATION_ITEM',
'PLANT_SPATIAL_CONFIGURATION.' +
'THERMODYNAMIC_TEMPERATURE_MEASURE_WITH_UNIT']) = 2) AND (
it.name IN ['temperature','minimum temperature',
'maximum temperature'])) )) AND (SIZEOF(QUERY ( it <* soc.
used_representation.items | ((SIZEOF(TYPEOF(it) * [
'PLANT_SPATIAL_CONFIGURATION.MEASURE_REPRESENTATION_ITEM',
'PLANT_SPATIAL_CONFIGURATION.' +
'THERMODYNAMIC_TEMPERATURE_MEASURE_WITH_UNIT']) = 2) AND (
it.name IN ['temperature','minimum temperature',
'maximum temperature'])) )) <= 2)) )) = 1)) )) = 0));
wr16: ((NOT (SIZEOF(QUERY ( pdr <* USEDIN(SELF,
'PLANT_SPATIAL_CONFIGURATION.' +

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'PROPERTY_DEFINITION_RELATIONSHIP.RELATING_PROPERTY_DEFINITION')
| (pdr.related_property_definition.name =
'service characteristics') ) >= 1)) OR (SIZEOF(
QUERY ( sc <* QUERY ( pdr <* USEDIN(SELF,
'PLANT_SPATIAL_CONFIGURATION.' +

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'PROPERTY_DEFINITION_RELATIONSHIP.RELATING_PROPERTY_DEFINITION')
| (pdr.related_property_definition.name =
'service characteristics') ) | (NOT (SIZEOF(QUERY ( soc <*
QUERY ( pdr <* USEDIN(sc.related_property_definition,
'PLANT_SPATIAL_CONFIGURATION.' +
'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') | (pdr.
used_representation.name =
'service operating characteristics') ) | (SIZEOF(
QUERY ( it <* soc.used_representation.items | ((SIZEOF(
TYPEOF(it) * [
'PLANT_SPATIAL_CONFIGURATION.MEASURE_REPRESENTATION_ITEM',
'PLANT_SPATIAL_CONFIGURATION.' +
'THERMODYNAMIC_TEMPERATURE_MEASURE_WITH_UNIT']) = 2) AND (
it.name = 'temperature')) )) <= 1)) = 1)) )) = 0));
wr17: ((NOT (SIZEOF(QUERY ( pdr <* USEDIN(SELF,
'PLANT_SPATIAL_CONFIGURATION.' +

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'PROPERTY_DEFINITION_RELATIONSHIP.RELATING_PROPERTY_DEFINITION')
| (pdr.related_property_definition.name =
'service characteristics') ) >= 1)) OR (SIZEOF(
QUERY ( sc <* QUERY ( pdr <* USEDIN(SELF,

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'PLANT\_SPATIAL\_CONFIGURATION.' +

'PROPERTY\_DEFINITION\_RELATIONSHIP.RELATING\_PROPERTY\_DEFINITION'  
 | (pdr.related\_property\_definition.name =  
 'service characteristics') ) | (NOT (SIZEOF(QUERY ( soc < \*  
 QUERY ( pdr < \* USEDIN(sc.related\_property\_definition,  
 'PLANT\_SPATIAL\_CONFIGURATION.' +  
 'PROPERTY\_DEFINITION\_REPRESENTATION.DEFINITION') | (pdr.  
 used\_representation.name =  
 'service operating characteristics') ) | (SIZEOF(  
 QUERY ( it < \* soc.used\_representation.items | ((SIZEOF(  
 TYPEOF(it) \* [  
 'PLANT\_SPATIAL\_CONFIGURATION.MEASURE\_REPRESENTATION\_ITEM',  
 'PLANT\_SPATIAL\_CONFIGURATION.' +  
 'THERMODYNAMIC\_TEMPERATURE\_MEASURE\_WITH\_UNIT']) = 2) AND (  
 it.name = 'minimum temperature')) ) <= 1) ) = 1) ) = 0));  
 wr18: ((NOT (SIZEOF(QUERY ( pdr < \* USEDIN(SELF,  
 'PLANT\_SPATIAL\_CONFIGURATION.' +

'PROPERTY\_DEFINITION\_RELATIONSHIP.RELATING\_PROPERTY\_DEFINITION'  
 | (pdr.related\_property\_definition.name =  
 'service characteristics') ) >= 1) ) OR (SIZEOF(  
 QUERY ( sc < \* QUERY ( pdr < \* USEDIN(SELF,  
 'PLANT\_SPATIAL\_CONFIGURATION.' +

'PROPERTY\_DEFINITION\_RELATIONSHIP.RELATING\_PROPERTY\_DEFINITION'  
 | (pdr.related\_property\_definition.name =  
 'service characteristics') ) | (NOT (SIZEOF(QUERY ( soc < \*  
 QUERY ( pdr < \* USEDIN(sc.related\_property\_definition,  
 'PLANT\_SPATIAL\_CONFIGURATION.' +  
 'PROPERTY\_DEFINITION\_REPRESENTATION.DEFINITION') | (pdr.  
 used\_representation.name =  
 'service operating characteristics') ) | (SIZEOF(  
 QUERY ( it < \* soc.used\_representation.items | ((SIZEOF(  
 TYPEOF(it) \* [  
 'PLANT\_SPATIAL\_CONFIGURATION.MEASURE\_REPRESENTATION\_ITEM',  
 'PLANT\_SPATIAL\_CONFIGURATION.' +  
 'THERMODYNAMIC\_TEMPERATURE\_MEASURE\_WITH\_UNIT']) = 2) AND (  
 it.name = 'maximum temperature')) ) <= 1) ) = 1) ) = 0));  
 wr19: ((NOT (SIZEOF(QUERY ( pdr < \* USEDIN(SELF,  
 'PLANT\_SPATIAL\_CONFIGURATION.' +

'PROPERTY\_DEFINITION\_RELATIONSHIP.RELATING\_PROPERTY\_DEFINITION'  
 | (pdr.related\_property\_definition.name =  
 'service characteristics') ) >= 1) ) OR (SIZEOF(  
 QUERY ( sc < \* QUERY ( pdr < \* USEDIN(SELF,  
 'PLANT\_SPATIAL\_CONFIGURATION.' +

'PROPERTY\_DEFINITION\_RELATIONSHIP.RELATING\_PROPERTY\_DEFINITION'  
 | (pdr.related\_property\_definition.name =  
 'service characteristics') ) | (NOT (SIZEOF(QUERY ( soc < \*

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QUERY ( pdr <* USEDIN(sc.related_property_definition,
'PLANT_SPATIAL_CONFIGURATION.' +
'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') | (pdr.
used_representation.name =
'service operating characteristics') ) | ((1 <= SIZEOF(
QUERY ( it <* soc.used_representation.items | ((
'PLANT_SPATIAL_CONFIGURATION.MEASURE_REPRESENTATION_ITEM'
IN TYPEOF(it)) AND (it.name IN ['pressure',
'minimum pressure','maximum pressure']))) AND (SIZEOF(
QUERY ( it <* soc.used_representation.items | ((
'PLANT_SPATIAL_CONFIGURATION.MEASURE_REPRESENTATION_ITEM'
IN TYPEOF(it)) AND (it.name IN ['pressure',
'minimum pressure','maximum pressure']))) <= 2)) ) = 1)) )
= 0));
wr20: ((NOT (SIZEOF(QUERY ( pdr <* USEDIN(SELF,
'PLANT_SPATIAL_CONFIGURATION.' +
'PROPERTY_DEFINITION_RELATIONSHIP.RELATING_PROPERTY_DEFINITION')
| (pdr.related_property_definition.name =
'service characteristics') ) >= 1)) OR (SIZEOF(
QUERY ( sc <* QUERY ( pdr <* USEDIN(SELF,
'PLANT_SPATIAL_CONFIGURATION.' +
'PROPERTY_DEFINITION_RELATIONSHIP.RELATING_PROPERTY_DEFINITION')
| (pdr.related_property_definition.name =
'service characteristics') ) | (NOT (SIZEOF(QUERY ( soc <*
QUERY ( pdr <* USEDIN(sc.related_property_definition,
'PLANT_SPATIAL_CONFIGURATION.' +
'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') | (pdr.
used_representation.name =
'service operating characteristics') ) | (SIZEOF(
QUERY ( it <* soc.used_representation.items | ((
'PLANT_SPATIAL_CONFIGURATION.MEASURE_REPRESENTATION_ITEM'
IN TYPEOF(it)) AND (it.name = 'pressure')) ) <= 1)) ) = 1)) )
= 0));
wr21: ((NOT (SIZEOF(QUERY ( pdr <* USEDIN(SELF,
'PLANT_SPATIAL_CONFIGURATION.' +
'PROPERTY_DEFINITION_RELATIONSHIP.RELATING_PROPERTY_DEFINITION')
| (pdr.related_property_definition.name =
'service characteristics') ) >= 1)) OR (SIZEOF(
QUERY ( sc <* QUERY ( pdr <* USEDIN(SELF,
'PLANT_SPATIAL_CONFIGURATION.' +
'PROPERTY_DEFINITION_RELATIONSHIP.RELATING_PROPERTY_DEFINITION')
| (pdr.related_property_definition.name =
'service characteristics') ) | (NOT (SIZEOF(QUERY ( soc <*
QUERY ( pdr <* USEDIN(sc.related_property_definition,
'PLANT_SPATIAL_CONFIGURATION.' +
'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') | (pdr.
used_representation.name =
'service operating characteristics') ) | (SIZEOF(
QUERY ( it <* soc.used_representation.items | ((
'PLANT_SPATIAL_CONFIGURATION.MEASURE_REPRESENTATION_ITEM'

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        IN TYPEOF(it)) AND (it.name = 'minimum pressure')) )) <= 1) ))
        = 1)) )) = 0));
wr22: ((NOT (SIZEOF(QUERY ( pdr <* USEDIN(SELF,
        'PLANT_SPATIAL_CONFIGURATION.' +

'PROPERTY_DEFINITION_RELATIONSHIP.RELATING_PROPERTY_DEFINITION')
        | (pdr.related_property_definition.name =
        'service characteristics') )) >= 1)) OR (SIZEOF(
        QUERY ( sc <* QUERY ( pdr <* USEDIN(SELF,
        'PLANT_SPATIAL_CONFIGURATION.' +

'PROPERTY_DEFINITION_RELATIONSHIP.RELATING_PROPERTY_DEFINITION')
        | (pdr.related_property_definition.name =
        'service characteristics') ) | (NOT (SIZEOF(QUERY ( soc <*
        QUERY ( pdr <* USEDIN(sc.related_property_definition,
        'PLANT_SPATIAL_CONFIGURATION.' +
        'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') | (pdr.
        used_representation.name =
        'service operating characteristics') ) | (SIZEOF(
        QUERY ( it <* soc.used_representation.items | ((
        'PLANT_SPATIAL_CONFIGURATION.MEASURE_REPRESENTATION_ITEM'
        IN TYPEOF(it)) AND (it.name = 'maximum pressure')) )) <= 1) ))
        = 1)) )) = 0));
wr23: ((NOT (SIZEOF(QUERY ( pdr <* USEDIN(SELF,
        'PLANT_SPATIAL_CONFIGURATION.' +

'PROPERTY_DEFINITION_RELATIONSHIP.RELATING_PROPERTY_DEFINITION')
        | (pdr.related_property_definition.name =
        'service characteristics') )) >= 1)) OR (SIZEOF(
        QUERY ( sc <* QUERY ( pdr <* USEDIN(SELF,
        'PLANT_SPATIAL_CONFIGURATION.' +

'PROPERTY_DEFINITION_RELATIONSHIP.RELATING_PROPERTY_DEFINITION')
        | (pdr.related_property_definition.name =
        'service characteristics') ) | (NOT (SIZEOF(QUERY ( soc <*
        QUERY ( pdr <* USEDIN(sc.related_property_definition,
        'PLANT_SPATIAL_CONFIGURATION.' +
        'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') | (pdr.
        used_representation.name =
        'service operating characteristics') ) | ((1 <= SIZEOF(
        QUERY ( it <* soc.used_representation.items | ((SIZEOF(
        TYPEOF(it) * [
        'PLANT_SPATIAL_CONFIGURATION.MEASURE_REPRESENTATION_ITEM',
        'PLANT_SPATIAL_CONFIGURATION.TIME_MEASURE_WITH_UNIT']) = 2)
        AND (it.name IN ['duration','minimum duration',
        'maximum duration']))) )) AND (SIZEOF(QUERY ( it <* soc.
        used_representation.items | ((SIZEOF(TYPEOF(it) * [
        'PLANT_SPATIAL_CONFIGURATION.MEASURE_REPRESENTATION_ITEM',
        'PLANT_SPATIAL_CONFIGURATION.TIME_MEASURE_WITH_UNIT']) = 2)
        AND (it.name IN ['duration','minimum duration',
        'maximum duration']))) )) <= 2)) )) = 1)) )) = 0));

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wr24: ((NOT (SIZEOF(QUERY ( pdr <* USEDIN(SELF,
    'PLANT_SPATIAL_CONFIGURATION.' +

'PROPERTY_DEFINITION_RELATIONSHIP.RELATING_PROPERTY_DEFINITION')
    | (pdr.related_property_definition.name =
    'service characteristics') )) >= 1)) OR (SIZEOF(
    QUERY ( sc <* QUERY ( pdr <* USEDIN(SELF,
    'PLANT_SPATIAL_CONFIGURATION.' +

'PROPERTY_DEFINITION_RELATIONSHIP.RELATING_PROPERTY_DEFINITION')
    | (pdr.related_property_definition.name =
    'service characteristics') ) | (NOT (SIZEOF(QUERY ( soc <*
    QUERY ( pdr <* USEDIN(sc.related_property_definition,
    'PLANT_SPATIAL_CONFIGURATION.' +
    'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') | (pdr.
    used_representation.name =
    'service operating characteristics') ) | (SIZEOF(
    QUERY ( it <* soc.used_representation.items | ((SIZEOF(
    TYPEOF(it) * [
    'PLANT_SPATIAL_CONFIGURATION.MEASURE_REPRESENTATION_ITEM',
    'PLANT_SPATIAL_CONFIGURATION.TIME_MEASURE_WITH_UNIT']) = 2)
    AND (it.name = 'duration')) ) <= 1) )) = 1) )) = 0));
wr25: ((NOT (SIZEOF(QUERY ( pdr <* USEDIN(SELF,
    'PLANT_SPATIAL_CONFIGURATION.' +

'PROPERTY_DEFINITION_RELATIONSHIP.RELATING_PROPERTY_DEFINITION')
    | (pdr.related_property_definition.name =
    'service characteristics') )) >= 1)) OR (SIZEOF(
    QUERY ( sc <* QUERY ( pdr <* USEDIN(SELF,
    'PLANT_SPATIAL_CONFIGURATION.' +

'PROPERTY_DEFINITION_RELATIONSHIP.RELATING_PROPERTY_DEFINITION')
    | (pdr.related_property_definition.name =
    'service characteristics') ) | (NOT (SIZEOF(QUERY ( soc <*
    QUERY ( pdr <* USEDIN(sc.related_property_definition,
    'PLANT_SPATIAL_CONFIGURATION.' +
    'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') | (pdr.
    used_representation.name =
    'service operating characteristics') ) | (SIZEOF(
    QUERY ( it <* soc.used_representation.items | ((SIZEOF(
    TYPEOF(it) * [
    'PLANT_SPATIAL_CONFIGURATION.MEASURE_REPRESENTATION_ITEM',
    'PLANT_SPATIAL_CONFIGURATION.TIME_MEASURE_WITH_UNIT']) = 2)
    AND (it.name = 'minimum duration')) ) <= 1) )) = 1) )) =
    0));
wr26: ((NOT (SIZEOF(QUERY ( pdr <* USEDIN(SELF,
    'PLANT_SPATIAL_CONFIGURATION.' +

'PROPERTY_DEFINITION_RELATIONSHIP.RELATING_PROPERTY_DEFINITION')
    | (pdr.related_property_definition.name =
    'service characteristics') )) >= 1)) OR (SIZEOF(
    QUERY ( sc <* QUERY ( pdr <* USEDIN(SELF,
    'PLANT_SPATIAL_CONFIGURATION.' +

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'PROPERTY_DEFINITION_RELATIONSHIP.RELATING_PROPERTY_DEFINITION')
  | (pdr.related_property_definition.name =
    'service characteristics') ) | (NOT (SIZEOF(QUERY ( soc <*
    QUERY ( pdr <* USEDIN(sc.related_property_definition,
    'PLANT_SPATIAL_CONFIGURATION.' +
    'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') | (pdr.
    used_representation.name =
    'service operating characteristics') ) | (SIZEOF(
    QUERY ( it <* soc.used_representation.items | ((SIZEOF(
    TYPEOF(it) * [
    'PLANT_SPATIAL_CONFIGURATION.MEASURE_REPRESENTATION_ITEM',
    'PLANT_SPATIAL_CONFIGURATION.TIME_MEASURE_WITH_UNIT']) = 2)
    AND (it.name = 'maximum duration')) )) <= 1) )) = 1)) )) =
    0));
wr27: ((NOT (SIZEOF(QUERY ( pdr <* USEDIN(SELF,
    'PLANT_SPATIAL_CONFIGURATION.' +

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'PROPERTY_DEFINITION_RELATIONSHIP.RELATING_PROPERTY_DEFINITION')
  | (pdr.related_property_definition.name =
    'service characteristics') )) >= 1)) OR (SIZEOF(
    QUERY ( sc <* QUERY ( pdr <* USEDIN(SELF,
    'PLANT_SPATIAL_CONFIGURATION.' +

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'PROPERTY_DEFINITION_RELATIONSHIP.RELATING_PROPERTY_DEFINITION')
  | (pdr.related_property_definition.name =
    'service characteristics') ) | (NOT (
    'PLANT_SPATIAL_CONFIGURATION.PLANT_ITEM_CONNECTOR' IN
    TYPEOF(sc.related_property_definition.definition))) )) = 0));
END_ENTITY; -- stream_design_case

```

ENTITY stream\_phase

SUBTYPE OF (property\_definition);

WHERE

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wr1 : ('PLANT_SPATIAL_CONFIGURATION.STREAM_DESIGN_CASE' IN TYPEOF(
    SELF.definition));
wr2 : (SIZEOF(QUERY ( pdr <* USEDIN(SELF,
    'PLANT_SPATIAL_CONFIGURATION.' +
    'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') | (pdr.
    used_representation.name = 'stream phase characteristics') ))
    = 1);
wr3 : (SIZEOF(QUERY ( spc <* QUERY ( pdr <* USEDIN(SELF,
    'PLANT_SPATIAL_CONFIGURATION.' +
    'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') | (pdr.
    used_representation.name = 'stream phase characteristics') )
    | (NOT (SIZEOF(spc.used_representation.items) >= 5)) )) =
    0);
wr4 : (SIZEOF(QUERY ( spc <* QUERY ( pdr <* USEDIN(SELF,
    'PLANT_SPATIAL_CONFIGURATION.' +
    'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') | (pdr.
    used_representation.name = 'stream phase characteristics') )

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| (NOT (SIZEOF(QUERY ( it <* spc.used_representation.items
| ((SIZEOF(TYPEOF(it) * [
'PLANT_SPATIAL_CONFIGURATION.MEASURE_REPRESENTATION_ITEM',
'PLANT_SPATIAL_CONFIGURATION.RATIO_MEASURE_WITH_UNIT']) = 2)
AND (it.name = 'constituent mole fraction')))) = 1))) =
0);
wr5 : (SIZEOF(QUERY ( spc <* QUERY ( pdr <* USEDIN(SELf,
'PLANT_SPATIAL_CONFIGURATION.' +
'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') | (pdr.
used_representation.name = 'stream phase characteristics' )
| (NOT (SIZEOF(QUERY ( it <* spc.used_representation.items |
((('PLANT_SPATIAL_CONFIGURATION.DESCRPTIVE_REPRESENTATION_ITEM'
IN TYPEOF(it)) AND (it.name = 'constituents')))) = 1))) )
= 0);
wr6 : (SIZEOF(QUERY ( spc <* QUERY ( pdr <* USEDIN(SELf,
'PLANT_SPATIAL_CONFIGURATION.' +
'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') | (pdr.
used_representation.name = 'stream phase characteristics' )
| (NOT (SIZEOF(QUERY ( it <* spc.used_representation.items
| ((
'PLANT_SPATIAL_CONFIGURATION.MEASURE_REPRESENTATION_ITEM'
IN TYPEOF(it)) AND (it.name = 'phase density')))) = 1))) )
= 0);
wr7 : (SIZEOF(QUERY ( spc <* QUERY ( pdr <* USEDIN(SELf,
'PLANT_SPATIAL_CONFIGURATION.' +
'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') | (pdr.
used_representation.name = 'stream phase characteristics' )
| (NOT (SIZEOF(QUERY ( it <* spc.used_representation.items
| ((SIZEOF(TYPEOF(it) * [
'PLANT_SPATIAL_CONFIGURATION.MEASURE_REPRESENTATION_ITEM',
'PLANT_SPATIAL_CONFIGURATION.RATIO_MEASURE_WITH_UNIT']) = 2)
AND (it.name = 'phase fraction')))) = 1))) = 0);
wr8 : (SIZEOF(QUERY ( spc <* QUERY ( pdr <* USEDIN(SELf,
'PLANT_SPATIAL_CONFIGURATION.' +
'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') | (pdr.
used_representation.name = 'stream phase characteristics' )
| (NOT ((1 <= SIZEOF(QUERY ( it <* spc.used_representation
.items | ((SIZEOF(TYPEOF(it) * [
'PLANT_SPATIAL_CONFIGURATION.MEASURE_REPRESENTATION_ITEM',
'PLANT_SPATIAL_CONFIGURATION.' +
'THERMODYNAMIC_TEMPERATURE_MEASURE_WITH_UNIT']) = 2) AND (
it.name IN ['temperature','minimum temperature',
'maximum temperature'])))) AND (SIZEOF(QUERY ( it <* spc.
used_representation.items | ((SIZEOF(TYPEOF(it) * [
'PLANT_SPATIAL_CONFIGURATION.MEASURE_REPRESENTATION_ITEM',
'PLANT_SPATIAL_CONFIGURATION.' +
'THERMODYNAMIC_TEMPERATURE_MEASURE_WITH_UNIT']) = 2) AND (
it.name IN ['temperature','minimum temperature',
'maximum temperature'])))) <= 2))) ) = 0);
wr9 : (SIZEOF(QUERY ( spc <* QUERY ( pdr <* USEDIN(SELf,
'PLANT_SPATIAL_CONFIGURATION.' +
'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') | (pdr.
used_representation.name = 'stream phase characteristics' )

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| (NOT (SIZEOF(QUERY ( it <* spc.used_representation.items
| ((SIZEOF(TYPEOF(it) * [
'PLANT_SPATIAL_CONFIGURATION.MEASURE_REPRESENTATION_ITEM',
'PLANT_SPATIAL_CONFIGURATION.' +
'THERMODYNAMIC_TEMPERATURE_MEASURE_WITH_UNIT']) = 2) AND (
it.name = 'temperature')) ) <= 1)) ) = 0);
wr10: (SIZEOF(QUERY ( spc <* QUERY ( pdr <* USEDIN(SELF,
'PLANT_SPATIAL_CONFIGURATION.' +
'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') | (pdr.
used_representation.name = 'stream phase characteristics') )
| (NOT (SIZEOF(QUERY ( it <* spc.used_representation.items
| ((SIZEOF(TYPEOF(it) * [
'PLANT_SPATIAL_CONFIGURATION.MEASURE_REPRESENTATION_ITEM',
'PLANT_SPATIAL_CONFIGURATION.' +
'THERMODYNAMIC_TEMPERATURE_MEASURE_WITH_UNIT']) = 2) AND (
it.name = 'minimum temperature')) ) <= 1)) ) = 0);
wr11: (SIZEOF(QUERY ( spc <* QUERY ( pdr <* USEDIN(SELF,
'PLANT_SPATIAL_CONFIGURATION.' +
'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') | (pdr.
used_representation.name = 'stream phase characteristics') )
| (NOT (SIZEOF(QUERY ( it <* spc.used_representation.items
| ((SIZEOF(TYPEOF(it) * [
'PLANT_SPATIAL_CONFIGURATION.MEASURE_REPRESENTATION_ITEM',
'PLANT_SPATIAL_CONFIGURATION.' +
'THERMODYNAMIC_TEMPERATURE_MEASURE_WITH_UNIT']) = 2) AND (
it.name = 'maximum temperature')) ) <= 1)) ) = 0);
wr12: (SIZEOF(QUERY ( spc <* QUERY ( pdr <* USEDIN(SELF,
'PLANT_SPATIAL_CONFIGURATION.' +
'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') | (pdr.
used_representation.name = 'stream phase characteristics') )
| (NOT (SIZEOF(QUERY ( it <* spc.used_representation.items
| ((
'PLANT_SPATIAL_CONFIGURATION.MEASURE_REPRESENTATION_ITEM'
IN TYPEOF(it)) AND (it.name = 'specific gravity')) ) <= 1)) )
= 0);
wr13: (SIZEOF(QUERY ( spc <* QUERY ( pdr <* USEDIN(SELF,
'PLANT_SPATIAL_CONFIGURATION.' +
'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') | (pdr.
used_representation.name = 'stream phase characteristics') )
| (NOT (SIZEOF(QUERY ( it <* spc.used_representation.items
| ((
'PLANT_SPATIAL_CONFIGURATION.MEASURE_REPRESENTATION_ITEM'
IN TYPEOF(it)) AND (it.name = 'surface tension')) ) <= 1)) )
= 0);
wr14: (SIZEOF(QUERY ( spc <* QUERY ( pdr <* USEDIN(SELF,
'PLANT_SPATIAL_CONFIGURATION.' +
'PROPERTY_DEFINITION_REPRESENTATION.DEFINITION') | (pdr.
used_representation.name = 'stream phase characteristics') )
| (NOT (SIZEOF(QUERY ( it <* spc.used_representation.items
| ((
'PLANT_SPATIAL_CONFIGURATION.MEASURE_REPRESENTATION_ITEM'

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        IN TYPEOF(it)) AND (it.name = 'viscosity')) )) <= 1)) )) =
        0);
END_ENTITY; -- stream_phase

ENTITY structural_load_connector_class
    SUBTYPE OF (group);
END_ENTITY; -- structural_load_connector_class

ENTITY structural_system
    SUBTYPE OF (product_definition);
    WHERE
        wr1: (SIZEOF(QUERY ( pdr <= USEDIN(SELF,
            'PLANT_SPATIAL_CONFIGURATION.' +
'PRODUCT_DEFINITION_RELATIONSHIP.RELATED_PRODUCT_DEFINITION')
            | (('PLANT_SPATIAL_CONFIGURATION.PLANT' IN TYPEOF(pdr.
            relating_product_definition.formation.of_product)) AND (pdr.
            relating_product_definition.frame_of_reference.name =
            'functional occurrence')) )) = 1);
END_ENTITY; -- structural_system

ENTITY support_constraint_representation
    SUBTYPE OF (representation);
    WHERE
        wr1: (SIZEOF(SELF.items) >= 3);
        wr2: (SIZEOF(QUERY ( it <= SELF.items | ((
            'PLANT_SPATIAL_CONFIGURATION.MEASURE_REPRESENTATION_ITEM' IN
            TYPEOF(it)) AND (it.name IN ['negative x','positive x',
            'negative y','positive y','negative z','positive z',
            'negative x rotation','positive x rotation',
            'negative y rotation','positive y rotation',
            'negative z rotation','positive z rotation'])) )) = 1);
        wr3: (SIZEOF(QUERY ( it <= SELF.items | (
            'PLANT_SPATIAL_CONFIGURATION.RATIO_MEASURE_WITH_UNIT' IN
            TYPEOF(it)) )) = 1);
        wr4: (SIZEOF(QUERY ( it <= SELF.items |
('PLANT_SPATIAL_CONFIGURATION.DESCRPTIVE_REPRESENTATION_ITEM'
        IN TYPEOF(it)) )) = 1);
END_ENTITY; -- support_constraint_representation

ENTITY surface
    SUPERTYPE OF (ONEOF (elementary_surface,swept_surface,bounded_surface,
        offset_surface,surface_replica))
    SUBTYPE OF (geometric_representation_item);
END_ENTITY; -- surface

ENTITY surface_curve
    SUPERTYPE OF (ONEOF (intersection_curve,seam_curve) ANDOR
        bounded_surface_curve)
    SUBTYPE OF (curve);
    curve_3d : curve;
    associated_geometry : LIST [1:2] OF pcurve_or_surface;
    master_representation : preferred_surface_curve_representation;
    DERIVE
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    basis_surface : SET [1:2] OF surface := get_basis_surface(SELf);
WHERE
    wr1: (curve_3d.dim = 3);
    wr2: (('PLANT_SPATIAL_CONFIGURATION.PCURVE' IN
        TYPEOF(associated_geometry[1]))
        OR (master_representation <> pcurve_s1));
    wr3: (('PLANT_SPATIAL_CONFIGURATION.PCURVE' IN
        TYPEOF(associated_geometry[2]))
        OR (master_representation <> pcurve_s2));
    wr4: (NOT ('PLANT_SPATIAL_CONFIGURATION.PCURVE' IN TYPEOF(curve_3d)));
END_ENTITY; -- surface_curve

ENTITY surface_of_linear_extrusion
    SUBTYPE OF (swept_surface);
    extrusion_axis : vector;
END_ENTITY; -- surface_of_linear_extrusion

ENTITY surface_of_revolution
    SUBTYPE OF (swept_surface);
    axis_position : axis1_placement;
    DERIVE
        axis_line : line := dummy_gri || curve() || line(axis_position.
            location,dummy_gri || vector(axis_position.z,1));
END_ENTITY; -- surface_of_revolution

ENTITY surface_patch
    SUBTYPE OF (founded_item);
    parent_surface : bounded_surface;
    u_transition : transition_code;
    v_transition : transition_code;
    u_sense : BOOLEAN;
    v_sense : BOOLEAN;
    INVERSE
        using_surfaces : BAG [1:?] OF rectangular_composite_surface FOR
            segments;
    WHERE
        wr1: (NOT ('PLANT_SPATIAL_CONFIGURATION.CURVE_BOUNDED_SURFACE' IN
            TYPEOF(
                parent_surface)));
END_ENTITY; -- surface_patch

ENTITY surface_replica
    SUBTYPE OF (surface);
    parent_surface : surface;
    transformation : cartesian_transformation_operator_3d;
    WHERE
        wr1: acyclic_surface_replica(SELf,parent_surface);
END_ENTITY; -- surface_replica

ENTITY swage_fitting_class
    SUBTYPE OF (group);

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WHERE
  wr1: (SIZEOF(QUERY ( aca <* QUERY ( ca <* USEDIN(SELF,
    'PLANT_SPATIAL_CONFIGURATION.CLASSIFICATION_ASSIGNMENT.' +
    'ASSIGNED_CLASS') |

('PLANT_SPATIAL_CONFIGURATION.APPLIED_CLASSIFICATION_ASSIGNMENT'
  IN TYPEOF(ca)) ) | (NOT (SIZEOF(QUERY ( it <* aca.items | (
    NOT (
      'PLANT_SPATIAL_CONFIGURATION.PIPING_COMPONENT_DEFINITION' IN
      TYPEOF(it))) )) = 0)) )) = 0);
  wr2: (SIZEOF(QUERY ( aca <* QUERY ( ca <* USEDIN(SELF,
    'PLANT_SPATIAL_CONFIGURATION.CLASSIFICATION_ASSIGNMENT.' +
    'ASSIGNED_CLASS') |

('PLANT_SPATIAL_CONFIGURATION.APPLIED_CLASSIFICATION_ASSIGNMENT'
  IN TYPEOF(ca)) ) | (NOT (SIZEOF(QUERY ( pcd <*
    QUERY ( it <* aca.items | (
      'PLANT_SPATIAL_CONFIGURATION.PIPING_COMPONENT_DEFINITION' IN
      TYPEOF(it)) ) | (NOT (SIZEOF(QUERY ( aca1 <* USEDIN(pcd.
        formation.of_product,'PLANT_SPATIAL_CONFIGURATION.' +
        'APPLIED_CLASSIFICATION_ASSIGNMENT.ITEMS') | class_in_tree(
          aca.assigned_class,'swage') )) = 1)) )) = 0)) )) = 0);
END_ENTITY; -- swage_fitting_class

ENTITY swept_area_solid
  SUPERTYPE OF (ONEOF (revolved_area_solid,extruded_area_solid))
  SUBTYPE OF (solid_model);
  swept_area : curve_bounded_surface;
  WHERE
    wr1: ('PLANT_SPATIAL_CONFIGURATION.PLANE' IN
  TYPEOF(swept_area.basis_surface));
END_ENTITY; -- swept_area_solid

ENTITY swept_face_solid
  SUPERTYPE OF (ONEOF (extruded_face_solid,revolved_face_solid))
  SUBTYPE OF (solid_model);
  swept_face : face_surface;
  WHERE
    wr1: ('PLANT_SPATIAL_CONFIGURATION.PLANE' IN
  TYPEOF(swept_face.face_geometry));
END_ENTITY; -- swept_face_solid

ENTITY swept_surface
  SUPERTYPE OF (ONEOF (surface_of_linear_extrusion,surface_of_revolution))
  SUBTYPE OF (surface);
  swept_curve : curve;
END_ENTITY; -- swept_surface

ENTITY symmetric_shape_aspect
  SUBTYPE OF (shape_aspect);
  INVERSE
    basis_relationships : SET [1:?] OF shape_aspect_relationship FOR
      relating_shape_aspect;
  WHERE

```

```

wr1: (SIZEOF(QUERY ( x <* SELF\symmetric_shape_aspect.
    basis_relationships | (
        'PLANT_SPATIAL_CONFIGURATION.CENTRE_OF_SYMMETRY' IN
        TYPEOF(x\shape_aspect_relationship.related_shape_aspect)) ))
    >= 1);
END_ENTITY; -- symmetric_shape_aspect

ENTITY system_class
    SUBTYPE OF (group);
    WHERE
        wr1: (SIZEOF(QUERY ( aca <* QUERY ( ca <* USEDIN(SELF,
            'PLANT_SPATIAL_CONFIGURATION.CLASSIFICATION_ASSIGNMENT.' +
            'ASSIGNED_CLASS') |
            ('PLANT_SPATIAL_CONFIGURATION.APPLIED_CLASSIFICATION_ASSIGNMENT'
                IN TYPEOF(ca)) ) | (NOT (SIZEOF(QUERY ( it <* aca.items | (
                NOT (SIZEOF(TYPEOF(it) * [
                'PLANT_SPATIAL_CONFIGURATION.CABLEWAY_SYSTEM',
                'PLANT_SPATIAL_CONFIGURATION.DUCTING_SYSTEM',
                'PLANT_SPATIAL_CONFIGURATION.ELECTRICAL_SYSTEM',
                'PLANT_SPATIAL_CONFIGURATION.INSTRUMENTATION_AND_CONTROL_SYSTEM'
                ,
                'PLANT_SPATIAL_CONFIGURATION.PIPING_SYSTEM',
                'PLANT_SPATIAL_CONFIGURATION.STRUCTURAL_SYSTEM']) = 1)) )) =
                0)) )) = 0);
END_ENTITY; -- system_class

ENTITY system_space
    SUBTYPE OF (product_definition_shape);
    WHERE
        wr1: (SIZEOF(TYPEOF(SELF.definition) * [
            'PLANT_SPATIAL_CONFIGURATION.ELECTRICAL_SYSTEM',
            'PLANT_SPATIAL_CONFIGURATION.DUCTING_SYSTEM',
            'PLANT_SPATIAL_CONFIGURATION.' +
            'INSTRUMENTATION_AND_CONTROL_SYSTEM',
            'PLANT_SPATIAL_CONFIGURATION.PIPING_SYSTEM',
            'PLANT_SPATIAL_CONFIGURATION.STRUCTURAL_SYSTEM']) = 1);
END_ENTITY; -- system_space

ENTITY thermodynamic_temperature_measure_with_unit
    SUBTYPE OF (measure_with_unit);
    WHERE
        wr1:
            ('PLANT_SPATIAL_CONFIGURATION.THERMODYNAMIC_TEMPERATURE_UNIT' IN
                TYPEOF(SELF\measure_with_unit.unit_component));
END_ENTITY; -- thermodynamic_temperature_measure_with_unit

ENTITY thermodynamic_temperature_unit
    SUBTYPE OF (named_unit);
    WHERE

```

```

wr1: ((SELF\named_unit.dimensions.length_exponent = 0) AND (SELF\
    named_unit.dimensions.mass_exponent = 0) AND (SELF\
    named_unit.dimensions.time_exponent = 0) AND (SELF\
    named_unit.dimensions.electric_current_exponent = 0) AND (
    SELF\named_unit.dimensions.
    thermodynamic_temperature_exponent = 1) AND (SELF\named_unit
    .dimensions.amount_of_substance_exponent = 0) AND (SELF\
    named_unit.dimensions.luminous_intensity_exponent = 0));
END_ENTITY; -- thermodynamic_temperature_unit

```

```

ENTITY time_measure_with_unit
  SUBTYPE OF (measure_with_unit);
  WHERE
    wr1: ('PLANT_SPATIAL_CONFIGURATION.TIME_UNIT' IN
        TYPEOF(SELF\measure_with_unit.unit_component));
END_ENTITY; -- time_measure_with_unit

```

```

ENTITY time_unit
  SUBTYPE OF (named_unit);
  WHERE
    wr1: ((SELF\named_unit.dimensions.length_exponent = 0) AND (SELF\
    named_unit.dimensions.mass_exponent = 0) AND (SELF\
    named_unit.dimensions.time_exponent = 1) AND (SELF\
    named_unit.dimensions.electric_current_exponent = 0) AND (
    SELF\named_unit.dimensions.
    thermodynamic_temperature_exponent = 0) AND (SELF\named_unit
    .dimensions.amount_of_substance_exponent = 0) AND (SELF\
    named_unit.dimensions.luminous_intensity_exponent = 0));
END_ENTITY; -- time_unit

```

```

ENTITY topological_representation_item
  SUPERTYPE OF (ONEOF (vertex,edge,face_bound,face,vertex_shell,
    wire_shell,connected_face_set,loop ANDOR path))
  SUBTYPE OF (representation_item);
END_ENTITY; -- topological_representation_item

```

```

ENTITY toroidal_surface
  SUBTYPE OF (elementary_surface);
  major_radius : positive_length_measure;
  minor_radius : positive_length_measure;
END_ENTITY; -- toroidal_surface

```

```

ENTITY torus
  SUBTYPE OF (geometric_representation_item);
  position : axis1_placement;
  major_radius : positive_length_measure;
  minor_radius : positive_length_measure;
  WHERE
    wr1: (major_radius > minor_radius);
END_ENTITY; -- torus

```

```

ENTITY trimmed_curve
  SUBTYPE OF (bounded_curve);
  basis_curve : curve;
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```

```

    trim_1          : SET [1:2] OF trimming_select;
    trim_2          : SET [1:2] OF trimming_select;
    sense_agreement  : BOOLEAN;
    master_representation : trimming_preference;
WHERE
    wr1: ((HIINDEX(trim_1) = 1) OR (TYPEOF(trim_1[1]) <> TYPEOF(trim_1[2])));
    wr2: ((HIINDEX(trim_2) = 1) OR (TYPEOF(trim_2[1]) <> TYPEOF(trim_2[2])));
END_ENTITY; -- trimmed_curve

ENTITY type_qualifier;
    name : label;
END_ENTITY; -- type_qualifier

ENTITY uncertainty_measure_with_unit
    SUBTYPE OF (measure_with_unit);
    name      : label;
    description : OPTIONAL text;
WHERE
    WR1: valid_measure_value (SELF\measure_with_unit.value_component);
END_ENTITY; -- uncertainty_measure_with_unit

ENTITY uniform_curve
    SUBTYPE OF (b_spline_curve);
END_ENTITY; -- uniform_curve

ENTITY uniform_surface
    SUBTYPE OF (b_spline_surface);
END_ENTITY; -- uniform_surface

ENTITY valve_class
    SUBTYPE OF (group);
WHERE
    wr1: (SIZEOF(QUERY ( aca <* QUERY ( ca <* USEDIN(SELF,
        'PLANT_SPATIAL_CONFIGURATION.CLASSIFICATION_ASSIGNMENT.' +
        'ASSIGNED_CLASS') |
('PLANT_SPATIAL_CONFIGURATION.APPLIED_CLASSIFICATION_ASSIGNMENT'
    IN TYPEOF(ca)) ) | (NOT (SIZEOF(QUERY ( it <* aca.items | (
    NOT (
        'PLANT_SPATIAL_CONFIGURATION.PIPING_COMPONENT_DEFINITION' IN
        TYPEOF(it))) )) = 0)) )) = 0);
    wr2: (SIZEOF(QUERY ( aca <* QUERY ( ca <* USEDIN(SELF,
        'PLANT_SPATIAL_CONFIGURATION.CLASSIFICATION_ASSIGNMENT.' +
        'ASSIGNED_CLASS') |
('PLANT_SPATIAL_CONFIGURATION.APPLIED_CLASSIFICATION_ASSIGNMENT'
    IN TYPEOF(ca)) ) | (NOT (SIZEOF(QUERY ( pcd <*
    QUERY ( it <* aca.items | (
        'PLANT_SPATIAL_CONFIGURATION.PIPING_COMPONENT_DEFINITION' IN
        TYPEOF(it)) ) | (NOT (SIZEOF(QUERY ( aca1 <* USEDIN(pcd.
        formation.of_product,'PLANT_SPATIAL_CONFIGURATION.' +

```

```

    'APPLIED_CLASSIFICATION_ASSIGNMENT.ITEMS') | class_in_tree(
      aca1.assigned_class,'valve') )) = 1)) )) = 0)) )) = 0);
END_ENTITY; -- valve_class

```

```

ENTITY vector
  SUBTYPE OF (geometric_representation_item);
    orientation : direction;
    magnitude   : length_measure;
  WHERE
    wr1: (magnitude >= 0);
END_ENTITY; -- vector

```

```

ENTITY versioned_action_request;
  id      : identifier;
  version : label;
  purpose : text;
  description : OPTIONAL text;
END_ENTITY; -- versioned_action_request

```

```

ENTITY vertex
  SUBTYPE OF (topological_representation_item);
END_ENTITY; -- vertex

```

```

ENTITY vertex_loop
  SUBTYPE OF (loop);
  loop_vertex : vertex;
END_ENTITY; -- vertex_loop

```

```

ENTITY vertex_point
  SUBTYPE OF (vertex,geometric_representation_item);
  vertex_geometry : point;
END_ENTITY;

```

```

ENTITY vertex_shell
  SUBTYPE OF (topological_representation_item);
  vertex_shell_extent : vertex_loop;
END_ENTITY; -- vertex_shell

```

```

ENTITY wire_shell
  SUBTYPE OF (topological_representation_item);
  wire_shell_extent : SET [1:?] OF loop;
  WHERE
    wr1: (NOT mixed_loop_type_set(wire_shell_extent));
END_ENTITY; -- wire_shell

```

```

RULE application_context_requires_ap_definition FOR (application_context,
  application_protocol_definition);

```

```

WHERE
  wr1: (SIZEOF(QUERY ( ac <= application_context | (NOT (SIZEOF(
    QUERY ( apd <= application_protocol_definition | ((ac := apd.
    application) AND (apd.
    application_interpreted_model_schema_name =
    'plant_spatial_configuration')) )) = 1)) )) = 0);

```

END\_RULE; -- application\_context\_requires\_ap\_definition

RULE approval\_requires\_approval\_date\_time FOR (approval\_date\_time,  
approval);

WHERE

wr1: (SIZEOF(QUERY ( app <\* approval | (NOT (SIZEOF(QUERY ( adt <\*  
approval\_date\_time | (app :=: adt.dated\_approval) )) = 1)) ))  
= 0);

END\_RULE; -- approval\_requires\_approval\_date\_time

RULE approval\_requires\_approval\_person\_organization FOR (  
approval\_person\_organization, approval);

WHERE

wr1: (SIZEOF(QUERY ( app <\* approval | (NOT (SIZEOF(QUERY ( apo <\*  
approval\_person\_organization | (app :=: apo.  
authorized\_approval) )) = 1)) )) = 0);

END\_RULE; -- approval\_requires\_approval\_person\_organization

RULE change\_action\_requires\_date FOR (change\_action,  
applied\_date\_assignment);

WHERE

wr1: (SIZEOF(QUERY ( ca <\* change\_action | (NOT (SIZEOF(  
QUERY ( pscda <\* applied\_date\_assignment | (ca IN pscda.items) ))  
= 1)) )) = 0);

END\_RULE; -- change\_action\_requires\_date

RULE change\_item\_requires\_creation\_date FOR (  
plant\_spatial\_configuration\_change\_assignment,  
applied\_date\_assignment);

WHERE

wr1: (SIZEOF(QUERY ( pscca <\*  
plant\_spatial\_configuration\_change\_assignment | (NOT (SIZEOF(  
QUERY ( ch\_it <\* pscca.items | (NOT (SIZEOF(QUERY ( pscda <\*  
applied\_date\_assignment | ((NOT (ch\_it IN pscda.items)) OR (  
pscda.role.name = 'creation date')) )) = 1)) )) = 0)) )) = 0);

END\_RULE; -- change\_item\_requires\_creation\_date

RULE change\_item\_requires\_id FOR (  
plant\_spatial\_configuration\_change\_assignment,  
change\_item\_id\_assignment);

WHERE

```

wr1: (SIZEOF(QUERY ( pscca <*
    plant_spatial_configuration_change_assignment | (NOT (SIZEOF(
    QUERY ( ch_it <* pscca.items | (NOT (SIZEOF(QUERY ( ciia <*
    change_item_id_assignment | (ch_it IN ciia.items) )) = 1)) ))
    = 0)) )) = 0);

END_RULE; -- change_item_requires_id

RULE change_life_cycle_stage_usage_requires_approval FOR (
    versioned_action_request, applied_approval_assignment);

WHERE
wr1: (SIZEOF(QUERY ( vareq <* versioned_action_request | (NOT (SIZEOF(
    QUERY ( pscaa <* applied_approval_assignment | (vareq IN pscaa
    .items) )) = 1)) )) = 0);

END_RULE; -- change_life_cycle_stage_usage_requires_approval

RULE change_life_cycle_stage_usage_requires_stage FOR (
    versioned_action_request, action_request_status);

WHERE
wr1: (SIZEOF(QUERY ( vareq <* versioned_action_request | (NOT (SIZEOF(
    QUERY ( ars <* action_request_status | (vareq :=: ars.
    assigned_request) )) = 1)) )) = 0);

END_RULE; -- change_life_cycle_stage_usage_requires_stage

RULE compatible_dimension FOR (cartesian_point, direction,
    geometric_representation_context);

WHERE
wr1: (SIZEOF(QUERY ( x <* cartesian_point | (SIZEOF(QUERY ( y <*
    geometric_representation_context | (item_in_context(x,y) AND (
    HIINDEX(x.coordinates) <> y.coordinate_space_dimension)) )) >
    0)) = 0);
wr2: (SIZEOF(QUERY ( x <* direction | (SIZEOF(QUERY ( y <*
    geometric_representation_context | (item_in_context(x,y) AND (
    HIINDEX(x.direction_ratios) <> y.coordinate_space_dimension)) ))
    > 0)) = 0);

END_RULE; -- compatible_dimension

RULE dependent_instantiable_application_context FOR (application_context);

WHERE
wr1: (SIZEOF(QUERY ( ac <* application_context | (NOT (SIZEOF(USEDIN(
    ac,")) >= 1)) )) = 0);

END_RULE; -- dependent_instantiable_application_context

RULE dependent_instantiable_half_space_solid FOR (half_space_solid);

WHERE

```

```
wr1: (SIZEOF(QUERY ( hss <* half_space_solid | (NOT (SIZEOF(USEDIN(
    hss,")) >= 1)) )) = 0);
```

```
END_RULE; -- dependent_instantiable_half_space_solid
```

```
RULE dependent_instantiable_product_context FOR (product_context);
```

```
WHERE
```

```
wr1: (SIZEOF(QUERY ( pc <* product_context | (NOT (SIZEOF(USEDIN(pc,"))
    >= 1)) )) = 0);
```

```
END_RULE; -- dependent_instantiable_product_context
```

```
RULE dependent_instantiable_product_definition_context FOR (
    product_definition_context);
```

```
WHERE
```

```
wr1: (SIZEOF(QUERY ( pdc <* product_definition_context | (NOT (SIZEOF(
    USEDIN(pdc,")) >= 1)) )) = 0);
```

```
END_RULE; -- dependent_instantiable_product_definition_context
```

```
RULE product_context_discipline_type_constraint FOR (product_context);
```

```
WHERE
```

```
wr1: (SIZEOF(QUERY ( pc <* product_context | (NOT (pc.discipline_type
    = 'process plant')) )) = 0);
```

```
END_RULE; -- product_context_discipline_type_constraint
```

```
RULE product_definition_context_name_constraint FOR (
    product_definition_context);
```

```
WHERE
```

```
wr1: (SIZEOF(QUERY ( pdc <* product_definition_context | (NOT (pd.
    name IN ['functional definition','physical definition',
    'functional occurrence','physical occurrence',
    'catalogue definition','fabrication assembly'])) )) = 0);
```

```
END_RULE; -- product_definition_context_name_constraint
```

```
RULE product_definition_usage_constraint FOR (product_definition);
```

```
WHERE
```

```
wr1: (SIZEOF(QUERY ( pd <* product_definition | ((pd.
    frame_of_reference.name = 'physical occurrence') AND (NOT (
    SIZEOF(QUERY ( pdr <* USEDIN(pd,
    'PLANT_SPATIAL_CONFIGURATION.PRODUCT_DEFINITION_RELATIONSHIP.'
    + 'RELATED_PRODUCT_DEFINITION') | (SIZEOF(TYPEOF(pdr) * [
    'PLANT_SPATIAL_CONFIGURATION.PRODUCT_DEFINITION_USAGE',
    'PLANT_SPATIAL_CONFIGURATION.MAKE_FROM_USAGE_OPTION',
```

```

        'PLANT_SPATIAL_CONFIGURATION.ASSEMBLY_COMPONENT_USAGE']) = 1)
    ))
    <= 1))) )) = 0);

END_RULE; -- product_definition_usage_constraint

RULE subtype_exclusive_characterized_object FOR (characterized_object);

WHERE
    wr1: (SIZEOF(QUERY ( co < * characterized_object | (NOT (SIZEOF([
        'PLANT_SPATIAL_CONFIGURATION.PIPING_COMPONENT_CLASS',
        'PLANT_SPATIAL_CONFIGURATION.SITE',
        'PLANT_SPATIAL_CONFIGURATION.STREAM_DESIGN_CASE'] * TYPEOF(co))
        <= 1))) )) = 0);

END_RULE; -- subtype_exclusive_characterized_object

RULE subtype_mandatory_externally_defined_item FOR (
    externally_defined_item);

WHERE
    wr1: (SIZEOF(QUERY ( edi < * externally_defined_item | (NOT (SIZEOF([
        'PLANT_SPATIAL_CONFIGURATION.CATALOGUE_CONNECTOR',
        'PLANT_SPATIAL_CONFIGURATION.EXTERNALLY_DEFINED_CLASS',
        'PLANT_SPATIAL_CONFIGURATION.EXTERNALLY_DEFINED_PLANT_ITEM_DEFINITION',
        'PLANT_SPATIAL_CONFIGURATION.EXTERNALLY_DEFINED_DOCUMENT'] *
        TYPEOF(edi)) = 1))) )) = 0);

END_RULE; -- subtype_mandatory_externally_defined_item

RULE subtype_mandatory_pre_defined_item FOR (pre_defined_item);

WHERE
    wr1: (SIZEOF(QUERY ( pdi < * pre_defined_item | (NOT (
        'PLANT_SPATIAL_CONFIGURATION.KNOWN_SOURCE' IN TYPEOF(pdi))) ))
        = 0);

END_RULE; -- subtype_mandatory_pre_defined_item

RULE subtype_mandatory_shape_representation FOR (shape_representation);

WHERE
    wr1: (SIZEOF(QUERY ( sr < * shape_representation | (NOT (SIZEOF([
        'PLANT_SPATIAL_CONFIGURATION.' +
        'PLANT_CSG_SHAPE_REPRESENTATION',
        'PLANT_SPATIAL_CONFIGURATION.HYBRID_SHAPE_REPRESENTATION',
        'PLANT_SPATIAL_CONFIGURATION.SHAPE_DIMENSION_REPRESENTATION',
        'PLANT_SPATIAL_CONFIGURATION.' + 'SITE_REPRESENTATION',
        'PLANT_SPATIAL_CONFIGURATION.PLANT_DESIGN_CSG_PRIMITIVE'] *
        TYPEOF(sr)) = 1))) )) = 0);

END_RULE; -- subtype_mandatory_shape_representation

```

RULE value\_for\_application\_context FOR (application\_context);

WHERE

wr1: (SIZEOF(QUERY ( ac <\* application\_context | (NOT (ac.application  
= 'plant spatial configuration')) )) = 0);

END\_RULE; -- value\_for\_application\_context

RULE version2\_p41\_object\_role\_selection FOR (role\_association);

WHERE

wr1: (SIZEOF(QUERY ( ra <\* role\_association | (NOT ((  
'PLANT\_SPATIAL\_CONFIGURATION.' +  
'PLANT\_SPATIAL\_CONFIGURATION\_CHANGE\_ASSIGNMENT') IN TYPEOF(ra.  
item\_with\_role)))) )) = 0);

END\_RULE; -- version2\_p41\_object\_role\_selection

RULE version2\_p41\_uninstantiable\_basic\_attributes FOR (  
description\_attribute, id\_attribute, name\_attribute);

WHERE

wr1: (SIZEOF(bag\_to\_set(description\_attribute)) = 0);  
wr2: (SIZEOF(bag\_to\_set(id\_attribute)) = 0);  
wr3: (SIZEOF(bag\_to\_set(name\_attribute)) = 0);

END\_RULE; -- version2\_p41\_uninstantiable\_basic\_attributes

FUNCTION acyclic\_curve\_replica(  
rep: curve\_replica;  
parent: curve

): BOOLEAN;

IF NOT ('PLANT\_SPATIAL\_CONFIGURATION.CURVE\_REPLICA' IN TYPEOF(parent))

THEN

RETURN(TRUE);

END\_IF;

IF parent :=: rep THEN

RETURN(FALSE);

ELSE

RETURN(acyclic\_curve\_replica(rep,parent\curve\_replica.parent\_curve));

END\_IF;

END\_FUNCTION; -- acyclic\_curve\_replica

FUNCTION acyclic\_mapped\_representation(  
parent\_set: SET OF representation;  
children\_set: SET OF representation\_item

): BOOLEAN;

LOCAL

LOCAL

```

    x : SET OF representation_item;
    y : SET OF representation_item;
END_LOCAL;
x := QUERY ( z < * children_set | ('PLANT_SPATIAL_CONFIGURATION.MAPPED_ITEM'
    IN TYPEOF(z)) );
IF SIZEOF(x) > 0 THEN
    REPEAT i := 1 TO HIINDEX(x) BY 1;
        IF x[i]\mapped_item.mapping_source.mapped_representation IN
            parent_set THEN
            RETURN(FALSE);
        END_IF;
        IF NOT acyclic_mapped_representation(parent_set + x[i]\mapped_item
            .mapping_source.mapped_representation,x[i]\mapped_item.
            mapping_source.mapped_representation.items) THEN
            RETURN(FALSE);
        END_IF;
    END_REPEAT;
END_IF;
x := children_set - x;
IF SIZEOF(x) > 0 THEN
    REPEAT i := 1 TO HIINDEX(x) BY 1;
        y := QUERY ( z < * bag_to_set(USEDIN(x[i],"")) | (
            'PLANT_SPATIAL_CONFIGURATION.REPRESENTATION_ITEM' IN TYPEOF(z))
    );
        IF NOT acyclic_mapped_representation(parent_set,y) THEN
            RETURN(FALSE);
        END_IF;
    END_REPEAT;
END_IF;
RETURN(TRUE);

END_FUNCTION; -- acyclic_mapped_representation

FUNCTION acyclic_point_replica(
    rep: point_replica;
    parent: point
): BOOLEAN;
IF NOT ('PLANT_SPATIAL_CONFIGURATION.POINT_REPLICA' IN TYPEOF(parent))
THEN
    RETURN(TRUE);
END_IF;
IF parent :=: rep THEN
    RETURN(FALSE);
ELSE
    RETURN(acyclic_point_replica(rep,parent\point_replica.parent_pt));
END_IF;

END_FUNCTION; -- acyclic_point_replica

FUNCTION acyclic_product_definition_relationship(
    relation: product_definition_relationship;
    relatives: SET [1:?] OF product_definition;
    specific_relation: STRING
): BOOLEAN;

```

```

LOCAL
  x : SET OF product_definition_relationship;
END_LOCAL;
IF relation.relatng_product_definition IN relatives THEN
  RETURN(FALSE);
END_IF;
x := QUERY ( pd <* bag_to_set(USEDIN(relation.
  relating_product_definition,'PLANT_SPATIAL_CONFIGURATION.' +
  'PRODUCT_DEFINITION_RELATIONSHIP.' + 'RELATED_PRODUCT_DEFINITION'))
  | (specific_relation IN TYPEOF(pd)) );
REPEAT i := 1 TO HIINDEX(x) BY 1;
  IF NOT acyclic_product_definition_relationship(x[i],relatives +
    relation.relatng_product_definition,specific_relation) THEN
    RETURN(FALSE);
  END_IF;
END_REPEAT;
RETURN(TRUE);

END_FUNCTION; -- acyclic_product_definition_relationship

FUNCTION acyclic_set_replica(
  rep: geometric_set_replica;
  parent: geometric_set
): BOOLEAN;
IF NOT ('PLANT_SPATIAL_CONFIGURATION.GEOMETRIC_SET_REPLICA' IN
  TYPEOF(parent))
  THEN
    RETURN(TRUE);
  END_IF;
IF parent :=: rep THEN
  RETURN(FALSE);
ELSE
  RETURN(acyclic_set_replica(rep,parent\geometric_set_replica.
    parent_set));
END_IF;

END_FUNCTION; -- acyclic_set_replica

FUNCTION acyclic_surface_replica(
  rep: surface_replica;
  parent: surface
): BOOLEAN;
IF NOT ('PLANT_SPATIAL_CONFIGURATION.SURFACE_REPLICA' IN
  TYPEOF(parent)) THEN
  RETURN(TRUE);
END_IF;
IF parent :=: rep THEN
  RETURN(FALSE);
ELSE
  RETURN(acyclic_surface_replica(rep,parent\surface_replica.

```

```

    parent_surface));
END_IF;

END_FUNCTION; -- acyclic_surface_replica

FUNCTION applied_identification_correlation(
    aia: applied_identification_assignment
): BOOLEAN;

LOCAL
    i_role : STRING;
END_LOCAL;
i_role := aia.identification_assignment.role.name;
CASE i_role OF
    'global unambiguous identifier' :    IF SIZEOF(aia.items) <>
        SIZEOF(QUERY ( x < * aia.items | (
            'PLANT_SPATIAL_CONFIGURATION.PRODUCT_DEFINITION' IN TYPEOF(x)) ))
        THEN
            RETURN(FALSE);
        END_IF;
    'stock code' :    IF SIZEOF(aia.items) <>
        SIZEOF(QUERY ( x < * aia.items | (
            'PLANT_SPATIAL_CONFIGURATION.PRODUCT_DEFINITION' IN TYPEOF(x)) ))
        THEN
            RETURN(FALSE);
        END_IF;
    'weld id' :    IF SIZEOF(aia.items) <>
        SIZEOF(QUERY ( x < * aia.items | (
            'PLANT_SPATIAL_CONFIGURATION.MATERIAL_PROPERTY' IN TYPEOF(x)) ))
        THEN
            RETURN(FALSE);
        END_IF;
    'connecting portion id' :    IF SIZEOF(aia.items) <>
        SIZEOF(QUERY ( x < * aia.items | (
            'PLANT_SPATIAL_CONFIGURATION.MATERIAL_PROPERTY' IN TYPEOF(x)) ))
        THEN
            RETURN(FALSE);
        END_IF;
    'analysis data point id' :    IF SIZEOF(aia.items) <>
        SIZEOF(QUERY ( x < * aia.items | (
            'PLANT_SPATIAL_CONFIGURATION.SHAPE_ASPECT' IN TYPEOF(x)) ))
        THEN
            RETURN(FALSE);
        END_IF;
    'document version id' :    IF SIZEOF(aia.items) <>
        SIZEOF(QUERY ( x < * aia.items | (
            'PLANT_SPATIAL_CONFIGURATION.DOCUMENT' IN TYPEOF(x)) )) THEN
            RETURN(FALSE);
        END_IF;
    OTHERWISE :    RETURN(TRUE);
END_CASE;
RETURN(TRUE);

END_FUNCTION; -- applied_identification_correlation

```

END\_FUNCTION; -- applied\_identification\_correlation

```

FUNCTION associated_surface(
    arg: pcurve_or_surface
): surface;

LOCAL
    surf : surface;
END_LOCAL;
IF 'PLANT_SPATIAL_CONFIGURATION.PCURVE' IN TYPEOF(arg) THEN
    surf := arg.basis_surface;
ELSE
    surf := arg;
END_IF;
RETURN(surf);

END_FUNCTION; -- associated_surface

FUNCTION bag_to_set(
    the_bag: BAG OF GENERIC:intype
): SET OF GENERIC:intype;

LOCAL
    i : INTEGER;
    the_set : SET OF GENERIC:intype := [];
END_LOCAL;
IF SIZEOF(the_bag) > 0 THEN
    REPEAT i := 1 TO HIINDEX(the_bag) BY 1;
        the_set := the_set + the_bag[i];
    END_REPEAT;
END_IF;
RETURN(the_set);

END_FUNCTION; -- bag_to_set

FUNCTION base_axis(
    dim: INTEGER;
    axis1, axis2, axis3: direction
): LIST [2:3] OF direction;

LOCAL
    u : LIST [2:3] OF direction;
    d1 : direction;
    d2 : direction;
    factor : REAL;
END_LOCAL;
IF dim = 3 THEN
    d1 := NVL(normalise(axis3), dummy_gri || direction([0,0,1]));
    d2 := first_proj_axis(d1, axis1);
    u := [d2, second_proj_axis(d1, d2, axis2), d1];
ELSE
    IF EXISTS(axis1) THEN

```

```

d1 := normalise(axis1);
u := [d1,orthogonal_complement(d1)];
IF EXISTS(axis2) THEN
  factor := dot_product(axis2,u[2]);
  IF factor < 0 THEN
    u[2].direction_ratios[1] := -u[2].direction_ratios[1];
    u[2].direction_ratios[2] := -u[2].direction_ratios[2];
  END_IF;
END_IF;
ELSE
  IF EXISTS(axis2) THEN
    d1 := normalise(axis2);
    u := [orthogonal_complement(d1),d1];
    u[1].direction_ratios[1] := -u[1].direction_ratios[1];
    u[1].direction_ratios[2] := -u[1].direction_ratios[2];
  ELSE
    u := [dummy_gri || direction([1,0]),dummy_gri || direction([0,1])];
  END_IF;
END_IF;
END_IF;
RETURN(u);

END_FUNCTION; -- base_axis

FUNCTION boolean_choose(
  b: BOOLEAN;
  choice1, choice2: GENERIC:item
): GENERIC:item;
IF b THEN
  RETURN(choice1);
ELSE
  RETURN(choice2);
END_IF;

END_FUNCTION; -- boolean_choose

FUNCTION build_2axes(
  ref_direction: direction
): LIST [2:2] OF direction;

LOCAL
  d : direction := NVL(normalise(ref_direction),dummy_gri ||
    direction([1,0]));
END_LOCAL;
RETURN([d,orthogonal_complement(d)]);

END_FUNCTION; -- build_2axes

FUNCTION build_axes(
  axis, ref_direction: direction
): LIST [3:3] OF direction;

LOCAL
  d1 : direction;
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```

```

    d2 : direction;
END_LOCAL;
d1 := NVL(normalise(axis),dummy_gri || direction([0,0,1]));
d2 := first_proj_axis(d1,ref_direction);
RETURN([d2,normalise(cross_product(d1,d2)).orientation,d1]);

END_FUNCTION; -- build_axes

FUNCTION build_transformed_set(
    tr: cartesian_transformation_operator;
    gset: geometric_set
): SET [0:?] OF geometric_set_select;

LOCAL
    s : SET [1:?] OF geometric_set_select := gset.elements;
    trset : SET [0:?] OF geometric_set_select := [];
END_LOCAL;
REPEAT j := 1 TO SIZEOF(s) BY 1;
    IF 'PLANT_SPATIAL_CONFIGURATION.CURVE' IN TYPEOF(s[j]) THEN
        trset := trset + curve_replica(s[j],tr);
    ELSE
        IF 'PLANT_SPATIAL_CONFIGURATION.POINT' IN TYPEOF(s[j]) THEN
            trset := trset + point_replica(s[j],tr);
        ELSE
            IF 'PLANT_SPATIAL_CONFIGURATION.SURFACE' IN TYPEOF(s[j]) THEN
                trset := trset + surface_replica(s[j],tr ||
                    cartesian_transformation_operator_3d(?));
            END_IF;
        END_IF;
    END_IF;
END_REPEAT;
RETURN(trset);

END_FUNCTION; -- build_transformed_set

FUNCTION class_in_tree(
    class: group;
    val: STRING
): BOOLEAN;
IF class.name = val THEN
    RETURN(TRUE);
ELSE
    RETURN(SIZEOF(QUERY ( gr <* USEDIN(class,
        'PLANT_SPATIAL_CONFIGURATION.' +
        'GROUP_RELATIONSHIP.RELATED_GROUP') | class_in_tree(gr.
        relating_group,val) )) = 1);
END_IF;
RETURN(FALSE);

END_FUNCTION; -- class_in_tree

```

```

FUNCTION closed_shell_reversed(
    a_shell: closed_shell
): oriented_closed_shell;

LOCAL
    the_reverse : oriented_closed_shell;
END_LOCAL;
IF 'PLANT_SPATIAL_CONFIGURATION.ORIENTED_CLOSED_SHELL' IN
TYPEOF(a_shell) THEN
    the_reverse := dummy_tri || connected_face_set(a_shell\
        connected_face_set.cfs_faces) || closed_shell() ||
        oriented_closed_shell(a_shell\oriented_closed_shell.
            closed_shell_element,NOT a_shell\oriented_closed_shell.
                orientation);
ELSE
    the_reverse := dummy_tri || connected_face_set(a_shell\
        connected_face_set.cfs_faces) || closed_shell() ||
        oriented_closed_shell(a_shell,FALSE);
END_IF;
RETURN(the_reverse);

END_FUNCTION; -- closed_shell_reversed

FUNCTION conditional_reverse(
    p: BOOLEAN;
    an_item: reversible_topology
): reversible_topology;
IF p THEN
    RETURN(an_item);
ELSE
    RETURN(topology_reversed(an_item));
END_IF;

END_FUNCTION; -- conditional_reverse

FUNCTION constraints_composite_curve_on_surface(
    c: composite_curve_on_surface
): BOOLEAN;

LOCAL
    n_segments : INTEGER := SIZEOF(c.segments);
END_LOCAL;
REPEAT k := 1 TO n_segments BY 1;
    IF (NOT ('PLANT_SPATIAL_CONFIGURATION.PCURVE' IN
TYPEOF(c\composite_curve.
    segments[k].parent_curve))) AND (NOT (
        'PLANT_SPATIAL_CONFIGURATION.SURFACE_CURVE' IN
        TYPEOF(c\composite_curve.segments[k].parent_curve))) AND (NOT (
        'PLANT_SPATIAL_CONFIGURATION.COMPOSITE_CURVE_ON_SURFACE' IN
        TYPEOF(c\composite_curve.segments[k].parent_curve))) THEN
        RETURN(FALSE);
    END_IF;
END_REPEAT;
RETURN(TRUE);

```

```

END_FUNCTION; -- constraints_composite_curve_on_surface

FUNCTION constraints_geometry_shell_based_wireframe_model(
    m: shell_based_wireframe_model
): BOOLEAN;

LOCAL
    result : BOOLEAN := TRUE;
END_LOCAL;
REPEAT j := 1 TO SIZEOF(m.sbwmm_boundary) BY 1;
    IF (NOT ('PLANT_SPATIAL_CONFIGURATION.WIRE_SHELL' IN
        TYPEOF(m.sbwmm_boundary[j])))
        AND (NOT ('PLANT_SPATIAL_CONFIGURATION.VERTEX_SHELL' IN
            TYPEOF(m.
                sbwmm_boundary[j]))) THEN
        result := FALSE;
        RETURN(result);
    END_IF;
END_REPEAT;
RETURN(result);

END_FUNCTION; -- constraints_geometry_shell_based_wireframe_model

FUNCTION constraints_param_b_spline(
    degree, up_knots, up_cp: INTEGER;
    knot_mult: LIST OF INTEGER;
    knots: LIST OF parameter_value
): BOOLEAN;

LOCAL
    k : INTEGER;
    sum : INTEGER;
    result : BOOLEAN := TRUE;
END_LOCAL;
sum := knot_mult[1];
REPEAT i := 2 TO up_knots BY 1;
    sum := sum + knot_mult[i];
END_REPEAT;
IF (degree < 1) OR (up_knots < 2) OR (up_cp < degree) OR (sum <> (
    degree + up_cp + 2)) THEN
    result := FALSE;
    RETURN(result);
END_IF;
k := knot_mult[1];
IF (k < 1) OR (k > (degree + 1)) THEN
    result := FALSE;
    RETURN(result);
END_IF;
REPEAT i := 2 TO up_knots BY 1;
    IF (knot_mult[i] < 1) OR (knots[i] <= knots[i - 1]) THEN

```

```

    result := FALSE;
    RETURN(result);
END_IF;
k := knot_mult[i];
IF (i < up_knots) AND (k > degree) THEN
    result := FALSE;
    RETURN(result);
END_IF;
IF (i = up_knots) AND (k > (degree + 1)) THEN
    result := FALSE;
    RETURN(result);
END_IF;
END_REPEAT;
RETURN(result);

END_FUNCTION; -- constraints_param_b_spline

FUNCTION constraints_rectangular_composite_surface(
    s: rectangular_composite_surface
): BOOLEAN;
REPEAT i := 1 TO s.n_u BY 1;
    REPEAT j := 1 TO s.n_v BY 1;
        IF NOT (('PLANT_SPATIAL_CONFIGURATION.B_SPLINE_SURFACE' IN
            TYPEOF(s.segments[i][j].parent_surface)) OR (
            'PLANT_SPATIAL_CONFIGURATION.RECTANGULAR_TRIMMED_SURFACE' IN
            TYPEOF(s.segments[i][j].parent_surface))) THEN
            RETURN(FALSE);
        END_IF;
    END_REPEAT;
END_REPEAT;
REPEAT i := 1 TO s.n_u - 1 BY 1;
    REPEAT j := 1 TO s.n_v BY 1;
        IF s.segments[i][j].u_transition = discontinuous THEN
            RETURN(FALSE);
        END_IF;
    END_REPEAT;
END_REPEAT;
REPEAT i := 1 TO s.n_u BY 1;
    REPEAT j := 1 TO s.n_v - 1 BY 1;
        IF s.segments[i][j].v_transition = discontinuous THEN
            RETURN(FALSE);
        END_IF;
    END_REPEAT;
END_REPEAT;
RETURN(TRUE);

END_FUNCTION; -- constraints_rectangular_composite_surface

FUNCTION cross_product(
    arg1, arg2: direction
): vector;

LOCAL
    v2 : LIST [3:3] OF REAL;
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```

```

    v1 : LIST [3:3] OF REAL;
    mag : REAL;
    res : direction;
    result : vector;
END_LOCAL;
IF (NOT EXISTS(arg1)) OR (arg1.dim = 2) OR (NOT EXISTS(arg2)) OR (arg2
    .dim = 2) THEN
    RETURN(?);
ELSE
    BEGIN
        v1 := normalise(arg1).direction_ratios;
        v2 := normalise(arg2).direction_ratios;
        res := dummy_gri || direction([(v1[2] * v2[3]) - (v1[3] * v2[2]),(
            v1[3] * v2[1]) - (v1[1] * v2[3]),(v1[1] * v2[2]) - (v1[2] * v2[
                1])));
        mag := 0;
        REPEAT i := 1 TO 3 BY 1;
            mag := mag + (res.direction_ratios[i] * res.direction_ratios[i]);
        END_REPEAT;
        IF mag > 0 THEN
            result := dummy_gri || vector(res,SQRT(mag));
        ELSE
            result := dummy_gri || vector(arg1,0);
        END_IF;
        RETURN(result);
    END;
END_IF;

END_FUNCTION; -- cross_product

FUNCTION curve_weights_positive(
    b: rational_b_spline_curve
): BOOLEAN;

LOCAL
    result : BOOLEAN := TRUE;
END_LOCAL;
REPEAT i := 0 TO b.upper_index_on_control_points BY 1;
    IF b.weights[i] <= 0 THEN
        result := FALSE;
        RETURN(result);
    END_IF;
END_REPEAT;
RETURN(result);

END_FUNCTION; -- curve_weights_positive

FUNCTION derive_dimensional_exponents(
    x: unit
): dimensional_exponents;

```

```

LOCAL
  result : dimensional_exponents := dimensional_exponents(0,0,0,0,0,0,
    0);
END_LOCAL;
IF 'PLANT_SPATIAL_CONFIGURATION.DERIVED_UNIT' IN TYPEOF(x) THEN
  REPEAT i := LOINDEX(x.elements) TO HIINDEX(x.elements) BY 1;
    result.length_exponent := result.length_exponent + (x.elements[i].
      exponent * x.elements[i].unit.dimensions.length_exponent);
    result.mass_exponent := result.mass_exponent + (x.elements[i].
      exponent * x.elements[i].unit.dimensions.mass_exponent);
    result.time_exponent := result.time_exponent + (x.elements[i].
      exponent * x.elements[i].unit.dimensions.time_exponent);
    result.electric_current_exponent := result.
      electric_current_exponent + (x.elements[i].exponent * x.
        elements[i].unit.dimensions.electric_current_exponent);
    result.thermodynamic_temperature_exponent := result.
      thermodynamic_temperature_exponent + (x.elements[i].exponent *
        x.elements[i].unit.dimensions.
          thermodynamic_temperature_exponent);
    result.amount_of_substance_exponent := result.
      amount_of_substance_exponent + (x.elements[i].exponent * x.
        elements[i].unit.dimensions.amount_of_substance_exponent);
    result.luminous_intensity_exponent := result.
      luminous_intensity_exponent + (x.elements[i].exponent * x.
        elements[i].unit.dimensions.luminous_intensity_exponent);
  END_REPEAT;
ELSE
  result := x.dimensions;
END_IF;
RETURN(result);

END_FUNCTION; -- derive_dimensional_exponents

FUNCTION dimension_of(
  item: geometric_representation_item
): dimension_count;

LOCAL
  x : SET OF representation;
  y : representation_context;
  dim : dimension_count;
END_LOCAL;
IF 'PLANT_SPATIAL_CONFIGURATION.CARTESIAN_POINT' IN TYPEOF(item) THEN
  dim := SIZEOF(item\cartesian_point.coordinates);
  RETURN(dim);
END_IF;
IF 'PLANT_SPATIAL_CONFIGURATION.DIRECTION' IN TYPEOF(item) THEN
  dim := SIZEOF(item\direction.direction_ratios);
  RETURN(dim);
END_IF;
IF 'PLANT_SPATIAL_CONFIGURATION.VECTOR' IN TYPEOF(item) THEN
  dim := SIZEOF(item\vector.orientation\direction.direction_ratios);
  RETURN(dim);
END_IF;

```

```

x := using_representations(item);
y := x[1].context_of_items;
dim := y\geometric_representation_context.coordinate_space_dimension;
RETURN(dim);

```

```
END_FUNCTION; -- dimension_of
```

```
FUNCTION dimensions_for_si_unit(
```

```

    n: si_unit_name
): dimensional_exponents;
```

```
CASE n OF
```

```

    metre      : RETURN(dimensional_exponents(1,0,0,0,0,0,0));
    gram       : RETURN(dimensional_exponents(0,1,0,0,0,0,0));
    second     : RETURN(dimensional_exponents(0,0,1,0,0,0,0));
    ampere     : RETURN(dimensional_exponents(0,0,0,1,0,0,0));
    kelvin     : RETURN(dimensional_exponents(0,0,0,0,1,0,0));
    mole       : RETURN(dimensional_exponents(0,0,0,0,0,1,0));
    candela    : RETURN(dimensional_exponents(0,0,0,0,0,0,1));
    radian     : RETURN(dimensional_exponents(0,0,0,0,0,0,0));
    steradian  : RETURN(dimensional_exponents(0,0,0,0,0,0,0));
    hertz      : RETURN(dimensional_exponents(0,0,-1,0,0,0,0));
    newton     : RETURN(dimensional_exponents(1,1,-2,0,0,0,0));
    pascal     : RETURN(dimensional_exponents(-1,1,-2,0,0,0,0));
    joule      : RETURN(dimensional_exponents(2,1,-2,0,0,0,0));
    watt       : RETURN(dimensional_exponents(2,1,-3,0,0,0,0));
    coulomb    : RETURN(dimensional_exponents(0,0,1,1,0,0,0));
    volt       : RETURN(dimensional_exponents(2,1,-3,-1,0,0,0));
    farad      : RETURN(dimensional_exponents(-2,-1,4,1,0,0,0));
    ohm        : RETURN(dimensional_exponents(2,1,-3,-2,0,0,0));
    siemens    : RETURN(dimensional_exponents(-2,-1,3,2,0,0,0));
    weber      : RETURN(dimensional_exponents(2,1,-2,-1,0,0,0));
    tesla      : RETURN(dimensional_exponents(0,1,-2,-1,0,0,0));
    henry      : RETURN(dimensional_exponents(2,1,-2,-2,0,0,0));
    degree_celsius : RETURN(dimensional_exponents(0,0,0,0,1,0,0));
    lumen      : RETURN(dimensional_exponents(0,0,0,0,0,0,1));
    lux        : RETURN(dimensional_exponents(-2,0,0,0,0,0,1));
    becquerel  : RETURN(dimensional_exponents(0,0,-1,0,0,0,0));
    gray       : RETURN(dimensional_exponents(2,0,-2,0,0,0,0));
    sievert    : RETURN(dimensional_exponents(2,0,-2,0,0,0,0));
    OTHERWISE  : RETURN(?);
END_CASE;

```

```
END_FUNCTION; -- dimensions_for_si_unit
```

```

FUNCTION dot_product(
    arg1, arg2: direction
): REAL;

```

```
LOCAL
```

```

    ndim : INTEGER;
    scalar : REAL;

```

```

    vec1 : direction;
    vec2 : direction;
END_LOCAL;
IF (NOT EXISTS(arg1)) OR (NOT EXISTS(arg2)) THEN
    scalar := ?;
ELSE
    IF arg1.dim <> arg2.dim THEN
        scalar := ?;
    ELSE
        BEGIN
            vec1 := normalise(arg1);
            vec2 := normalise(arg2);
            ndim := arg1.dim;
            scalar := 0;
            REPEAT i := 1 TO ndim BY 1;
                scalar := scalar + (vec1.direction_ratios[i] * vec2.
                    direction_ratios[i]);
            END_REPEAT;
        END;
    END_IF;
END_IF;
RETURN(scalar);

END_FUNCTION; -- dot_product

FUNCTION edge_reversed(
    an_edge: edge
): oriented_edge;

LOCAL
    the_reverse : oriented_edge;
END_LOCAL;
IF 'PLANT_SPATIAL_CONFIGURATION.ORIENTED_EDGE' IN TYPEOF(an_edge)
THEN
    the_reverse := dummy_tri || edge(an_edge.edge_end,an_edge.edge_start)
        || oriented_edge(an_edge\oriented_edge.edge_element,NOT an_edge\
            oriented_edge.orientation);
ELSE
    the_reverse := dummy_tri || edge(an_edge.edge_end,an_edge.edge_start)
        || oriented_edge(an_edge,FALSE);
END_IF;
RETURN(the_reverse);

END_FUNCTION; -- edge_reversed

FUNCTION face_bound_reversed(
    a_face_bound: face_bound
): face_bound;

LOCAL
    the_reverse : face_bound;
END_LOCAL;
IF 'PLANT_SPATIAL_CONFIGURATION.FACE_OUTER_BOUND' IN
TYPEOF(a_face_bound) THEN
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```

```

    the_reverse := dummy_tri || face_bound(a_face_bound\face_bound.bound,
      NOT a_face_bound\face_bound.orientation) || face_outer_bound();
  ELSE
    the_reverse := dummy_tri || face_bound(a_face_bound.bound, NOT
      a_face_bound.orientation);
  END_IF;
  RETURN(the_reverse);

END_FUNCTION; -- face_bound_reversed

FUNCTION face_reversed(
  a_face: face
): oriented_face;

LOCAL
  the_reverse : oriented_face;
END_LOCAL;
IF 'PLANT_SPATIAL_CONFIGURATION.ORIENTED_FACE' IN TYPEOF(a_face) THEN
  the_reverse := dummy_tri || face(set_of_topology_reversed(a_face.
    bounds)) || oriented_face(a_face\oriented_face.face_element, NOT
    a_face\oriented_face.orientation);
ELSE
  the_reverse := dummy_tri || face(set_of_topology_reversed(a_face.
    bounds)) || oriented_face(a_face, FALSE);
END_IF;
RETURN(the_reverse);

END_FUNCTION; -- face_reversed

FUNCTION first_proj_axis(
  z_axis, arg: direction
): direction;

LOCAL
  x_vec : vector;
  v     : direction;
  z     : direction;
  x_axis : direction;
END_LOCAL;
IF NOT EXISTS(z_axis) THEN
  RETURN(?);
ELSE
  z := normalise(z_axis);
  IF NOT EXISTS(arg) THEN
    IF z.direction_ratios <> [1,0,0] THEN
      v := dummy_gri || direction([1,0,0]);
    ELSE
      v := dummy_gri || direction([0,1,0]);
    END_IF;
  ELSE
    IF arg.dim <> 3 THEN

```

```

    RETURN(?);
END_IF;
IF cross_product(arg,z).magnitude = 0 THEN
    RETURN(?);
ELSE
    v := normalise(arg);
    END_IF;
END_IF;
x_vec := scalar_times_vector(dot_product(v,z),z);
x_axis := vector_difference(v,x_vec).orientation;
x_axis := normalise(x_axis);
END_IF;
RETURN(x_axis);

END_FUNCTION; -- first_proj_axis

FUNCTION get_basis_surface(
    c: curve_on_surface
): SET [0:2] OF surface;

LOCAL
    surfs : SET [0:2] OF surface;
    n : INTEGER;
END_LOCAL;
surfs := [];
IF 'PLANT_SPATIAL_CONFIGURATION.PCURVE' IN TYPEOF(c) THEN
    surfs := [c\pcurve.basis_surface];
ELSE
    IF 'PLANT_SPATIAL_CONFIGURATION.SURFACE_CURVE' IN TYPEOF(c) THEN
        n := SIZEOF(c\surface_curve.associated_geometry);
        REPEAT i := 1 TO n BY 1;
            surfs := surfs + associated_surface(c\surface_curve.
                associated_geometry[i]);
        END_REPEAT;
    END_IF;
END_IF;
IF 'PLANT_SPATIAL_CONFIGURATION.COMPOSITE_CURVE_ON_SURFACE' IN
TYPEOF(c)
THEN
    n := SIZEOF(c\composite_curve.segments);
    surfs := get_basis_surface(c\composite_curve.segments[1].
        parent_curve);
    IF n > 1 THEN
        REPEAT i := 2 TO n BY 1;
            surfs := surfs * get_basis_surface(c\composite_curve.segments[i]
                .parent_curve);
        END_REPEAT;
    END_IF;
END_IF;
RETURN(surfs);

END_FUNCTION; -- get_basis_surface

FUNCTION get_description_value(
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```

```

        obj: description_attribute_select
    ): text;

LOCAL
    description_bag : BAG OF description_attribute := USEDIN(obj,
        'PLANT_SPATIAL_CONFIGURATION.' +
        'DESCRIPTION_ATTRIBUTE.' + 'DESCRIBED_ITEM');
END_LOCAL;
IF SIZEOF(description_bag) = 1 THEN
    RETURN(description_bag[1].attribute_value);
ELSE
    RETURN(?);
END_IF;

END_FUNCTION; -- get_description_value

FUNCTION get_id_value(
    obj: id_attribute_select
): identifier;

LOCAL
    id_bag : BAG OF id_attribute := USEDIN(obj, 'PLANT_SPATIAL_CONFIGURATION.'
        + 'ID_ATTRIBUTE.' + 'IDENTIFIED_ITEM');
END_LOCAL;
IF SIZEOF(id_bag) = 1 THEN
    RETURN(id_bag[1].attribute_value);
ELSE
    RETURN(?);
END_IF;

END_FUNCTION; -- get_id_value

FUNCTION get_name_value(
    obj: name_attribute_select
): label;

LOCAL
    name_bag : BAG OF name_attribute := USEDIN(obj,
        'PLANT_SPATIAL_CONFIGURATION.' + 'NAME_ATTRIBUTE.' +
        'NAMED_ITEM');
END_LOCAL;
IF SIZEOF(name_bag) = 1 THEN
    RETURN(name_bag[1].attribute_value);
ELSE
    RETURN(?);
END_IF;

END_FUNCTION; -- get_name_value

FUNCTION get_role(
    obj: role_select

```

```

    ): object_role;

LOCAL
    role_bag : BAG OF role_association := USEDIN(obj,
        'PLANT_SPATIAL_CONFIGURATION.' + 'ROLE_ASSOCIATION.' +
        'ITEM_WITH_ROLE');
END_LOCAL;
IF SIZEOF(role_bag) = 1 THEN
    RETURN(role_bag[1].role);
ELSE
    RETURN(?);
END_IF;

END_FUNCTION; -- get_role

FUNCTION item_in_context(
    item: representation_item;
    cntxt: representation_context
): BOOLEAN;

LOCAL
    y : BAG OF representation_item;
END_LOCAL;
IF
    SIZEOF(USEDIN(item, 'PLANT_SPATIAL_CONFIGURATION.REPRESENTATION.ITEMS'))
    *
        cntxt.representations_in_context) > 0 THEN
    RETURN(TRUE);
ELSE
    y := QUERY ( z < * USEDIN(item, " ) | (
        'PLANT_SPATIAL_CONFIGURATION.REPRESENTATION_ITEM' IN TYPEOF(z) ) );
    IF SIZEOF(y) > 0 THEN
        REPEAT i := 1 TO HIINDEX(y) BY 1;
            IF item_in_context(y[i], cntxt) THEN
                RETURN(TRUE);
            END_IF;
        END_REPEAT;
    END_IF;
    RETURN(FALSE);
END_IF;

END_FUNCTION; -- item_in_context

FUNCTION leap_year(
    year: year_number
): BOOLEAN;
IF (((year MOD 4) = 0) AND ((year MOD 100) <> 0)) OR ((year MOD 400) =
    0) THEN
    RETURN(TRUE);
ELSE
    RETURN(FALSE);
END_IF;

END_FUNCTION; -- leap_year

```

```

FUNCTION list_face_loops(
    f: face
): LIST [0:?] OF loop;

LOCAL
    loops : LIST [0:?] OF loop := [];
END_LOCAL;
REPEAT i := 1 TO SIZEOF(f.bounds) BY 1;
    loops := loops + f.bounds[i].bound;
END_REPEAT;
RETURN(loops);

END_FUNCTION; -- list_face_loops

FUNCTION list_of_topology_reversed(
    a_list: list_of_reversible_topology_item
): list_of_reversible_topology_item;

LOCAL
    the_reverse : list_of_reversible_topology_item;
END_LOCAL;
the_reverse := [];
REPEAT i := 1 TO SIZEOF(a_list) BY 1;
    the_reverse := topology_reversed(a_list[i]) + the_reverse;
END_REPEAT;
RETURN(the_reverse);

END_FUNCTION; -- list_of_topology_reversed

FUNCTION list_to_array(
    lis: LIST [0:?] OF GENERIC:t;
    low, u: INTEGER
): ARRAY OF GENERIC:t;

LOCAL
    n : INTEGER;
    res : ARRAY [low:u] OF GENERIC:t;
END_LOCAL;
n := SIZEOF(lis);
IF n <> ((u - low) + 1) THEN
    RETURN(?);
ELSE
    res := [lis[1],n];
    REPEAT i := 2 TO n BY 1;
        res[(low + i) - 1] := lis[i];
    END_REPEAT;
    RETURN(res);
END_IF;

END_FUNCTION; -- list_to_array

```

```

FUNCTION list_to_set(
    l: LIST [0:?] OF GENERIC:t
): SET OF GENERIC:t;

LOCAL
    s : SET OF GENERIC:t := [];
END_LOCAL;
REPEAT i := 1 TO SIZEOF(l) BY 1;
    s := s + l[i];
END_REPEAT;
RETURN(s);

END_FUNCTION; -- list_to_set

FUNCTION make_array_of_array(
    lis: LIST [1:?] OF LIST [1:?] OF GENERIC:t;
    low1, u1, low2, u2: INTEGER
): ARRAY OF ARRAY OF GENERIC:t;

LOCAL
    res : ARRAY [low1:u1] OF ARRAY [low2:u2] OF GENERIC:t;
END_LOCAL;
IF ((u1 - low1) + 1) <> SIZEOF(lis) THEN
    RETURN(?);
END_IF;
IF ((u2 - low2) + 1) <> SIZEOF(lis[1]) THEN
    RETURN(?);
END_IF;
res := [list_to_array(lis[1],low2,u2),(u1 - low1) + 1];
REPEAT i := 2 TO HIINDEX(lis) BY 1;
    IF ((u2 - low2) + 1) <> SIZEOF(lis[i]) THEN
        RETURN(?);
    END_IF;
    res[(low1 + i) - 1] := list_to_array(lis[i],low2,u2);
END_REPEAT;
RETURN(res);

END_FUNCTION; -- make_array_of_array

FUNCTION mixed_loop_type_set(
    l: SET [0:?] OF loop
): LOGICAL;

LOCAL
    poly_loop_type : LOGICAL;
END_LOCAL;
IF SIZEOF(l) <= 1 THEN
    RETURN(FALSE);
END_IF;
poly_loop_type := 'PLANT_SPATIAL_CONFIGURATION.POLY_LOOP' IN TYPEOF(l[1]);
REPEAT i := 2 TO SIZEOF(l) BY 1;
    IF ('PLANT_SPATIAL_CONFIGURATION.POLY_LOOP' IN TYPEOF(l[i])) <>
        poly_loop_type THEN

```

```

    RETURN(TRUE);
  END_IF;
END_REPEAT;
RETURN(FALSE);

```

```
END_FUNCTION; -- mixed_loop_type_set
```

```

FUNCTION normalise(
    arg: vector_or_direction
): vector_or_direction;

```

```

LOCAL
    ndim : INTEGER;
    v : direction;
    vec : vector;
    mag : REAL;
    result : vector_or_direction;
END_LOCAL;
IF NOT EXISTS(arg) THEN
    result := ?;
ELSE
    ndim := arg.dim;
    IF 'PLANT_SPATIAL_CONFIGURATION.VECTOR' IN TYPEOF(arg) THEN
        BEGIN
            v := dummy_gri || direction(arg.orientation.direction_ratios);
            IF arg.magnitude = 0 THEN
                RETURN(?);
            ELSE
                vec := dummy_gri || vector(v,1);
            END_IF;
        END;
    ELSE
        v := dummy_gri || direction(arg.direction_ratios);
    END_IF;
    mag := 0;
    REPEAT i := 1 TO ndim BY 1;
        mag := mag + (v.direction_ratios[i] * v.direction_ratios[i]);
    END_REPEAT;
    IF mag > 0 THEN
        mag := SQRT(mag);
        REPEAT i := 1 TO ndim BY 1;
            v.direction_ratios[i] := v.direction_ratios[i] / mag;
        END_REPEAT;
        IF 'PLANT_SPATIAL_CONFIGURATION.VECTOR' IN TYPEOF(arg) THEN
            vec.orientation := v;
            result := vec;
        ELSE
            result := v;
        END_IF;
    ELSE
        RETURN(?);
    END_IF;

```

```

    END_IF;
  END_IF;
  RETURN(result);

END_FUNCTION; -- normalise

FUNCTION open_shell_reversed(
    a_shell: open_shell
): oriented_open_shell;

LOCAL
    the_reverse : oriented_open_shell;
END_LOCAL;
IF 'PLANT_SPATIAL_CONFIGURATION.ORIENTED_OPEN_SHELL' IN
  TYPEOF(a_shell) THEN
    the_reverse := dummy_tri || connected_face_set(a_shell\
      connected_face_set.cfs_faces) || open_shell() ||
      oriented_open_shell(a_shell\oriented_open_shell.
        open_shell_element,NOT a_shell\oriented_open_shell.orientation);
  ELSE
    the_reverse := dummy_tri || connected_face_set(a_shell\
      connected_face_set.cfs_faces) || open_shell() ||
      oriented_open_shell(a_shell,FALSE);
  END_IF;
  RETURN(the_reverse);

END_FUNCTION; -- open_shell_reversed

FUNCTION orthogonal_complement(
    vec: direction
): direction;

LOCAL
    result : direction;
END_LOCAL;
IF (vec.dim <> 2) OR (NOT EXISTS(vec)) THEN
  RETURN(?);
ELSE
  result := dummy_gri || direction([-vec.direction_ratios[2],vec.
    direction_ratios[1]]);
  RETURN(result);
END_IF;

END_FUNCTION; -- orthogonal_complement

FUNCTION path_head_to_tail(
    a_path: path
): BOOLEAN;

LOCAL
    n : INTEGER;
    p : BOOLEAN := TRUE;
END_LOCAL;
n := SIZEOF(a_path.edge_list);
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```

```

REPEAT i := 2 TO n BY 1;
  p := p AND (a_path.edge_list[i - 1].edge_end :=: a_path.edge_list[i]
    .edge_start);
END_REPEAT;
RETURN(p);

```

```

END_FUNCTION; -- path_head_to_tail

```

```

FUNCTION path_reversed(
  a_path: path
): oriented_path;

```

```

LOCAL
  the_reverse : oriented_path;
END_LOCAL;
IF 'PLANT_SPATIAL_CONFIGURATION.ORIENTED_PATH' IN TYPEOF(a_path) THEN
  the_reverse := dummy_tri || path(list_of_topology_reversed(a_path.
    edge_list)) || oriented_path(a_path\oriented_path.path_element,
    NOT a_path\oriented_path.orientation);
ELSE
  the_reverse := dummy_tri || path(list_of_topology_reversed(a_path.
    edge_list)) || oriented_path(a_path,FALSE);
END_IF;
RETURN(the_reverse);

```

```

END_FUNCTION; -- path_reversed

```

```

FUNCTION plant_spatial_configuration_organization_correlation(
  e: plant_spatial_configuration_organization_assignment
): BOOLEAN;

```

```

LOCAL
  o_role : STRING;
END_LOCAL;
o_role := e\organization_assignment.role.name;
CASE o_role OF
  'vendor' : IF SIZEOF(e.items) <> SIZEOF(QUERY ( x < *
    e.items | (SIZEOF(['PLANT_SPATIAL_CONFIGURATION.PRODUCT',
    'PLANT_SPATIAL_CONFIGURATION.DOCUMENT'] * TYPEOF(x)) = 1) ))
    THEN
      RETURN(FALSE);
    END_IF;
  'owner' : IF SIZEOF(e.items) <> SIZEOF(QUERY ( x < *
    e.items | (SIZEOF(['PLANT_SPATIAL_CONFIGURATION.SITE',
    'PLANT_SPATIAL_CONFIGURATION.DOCUMENT'] * TYPEOF(x)) = 1) ))
    THEN
      RETURN(FALSE);
    END_IF;
  'plant operator' : IF SIZEOF(e.items) <> SIZEOF(
    QUERY ( x < * e.items | ('PLANT_SPATIAL_CONFIGURATION.PLANT' IN
    TYPEOF(x)) )) THEN

```

```

    RETURN(FALSE);
  END_IF;
  'plant owner' :    IF SIZEOF(e.items) <> SIZEOF(QUERY ( x < *
    e.items | ('PLANT_SPATIAL_CONFIGURATION.PLANT' IN TYPEOF(x)) ))
    THEN
    RETURN(FALSE);
  END_IF;
  'project owner' :  IF SIZEOF(e.items) <> SIZEOF(QUERY ( x < *
    e.items | ('PLANT_SPATIAL_CONFIGURATION.DESIGN_PROJECT' IN
    TYPEOF(x)) )) THEN
    RETURN(FALSE);
  END_IF;
  'assessor' :      IF SIZEOF(e.items) <> SIZEOF(QUERY ( x < *
    e.items | (('PLANT_SPATIAL_CONFIGURATION.' +
    'PRODUCT_DEFINITION_RELATIONSHIP') IN TYPEOF(x)) )) THEN
    RETURN(FALSE);
  END_IF;
  OTHERWISE :       RETURN(TRUE);
END_CASE;
RETURN(TRUE);

END_FUNCTION; -- plant_spatial_configuration_organization_correlation

FUNCTION plant_spatial_configuration_person_and_organization_correlation(
  e: plant_spatial_configuration_person_and_organization_assignment
): BOOLEAN;

LOCAL
  po_role : STRING;
END_LOCAL;
po_role := e.person_and_organization_assignment.role.name;
CASE po_role OF
  'owner' :        IF SIZEOF(e.items) <> SIZEOF(QUERY ( x < *
    e.items | (SIZEOF(['PLANT_SPATIAL_CONFIGURATION.SITE',
    'PLANT_SPATIAL_CONFIGURATION.' + 'CHANGE_ITEM'] * TYPEOF(x)) =
    1) )) THEN
    RETURN(FALSE);
  END_IF;
  'plant owner' :  IF SIZEOF(e.items) <> SIZEOF(QUERY ( x < *
    e.items | ('PLANT_SPATIAL_CONFIGURATION.PLANT' IN TYPEOF(x)) ))
    THEN
    RETURN(FALSE);
  END_IF;
  'plant operator' :  IF SIZEOF(e.items) <> SIZEOF(
    QUERY ( x < * e.items | ('PLANT_SPATIAL_CONFIGURATION.PLANT' IN
    TYPEOF(x)) )) THEN
    RETURN(FALSE);
  END_IF;
  OTHERWISE :       RETURN(TRUE);
END_CASE;
RETURN(TRUE);

END_FUNCTION; -- plant_spatial_configuration_person_and_organization_correlation

```

```

FUNCTION plant_spatial_configuration_person_correlation(
    e: plant_spatial_configuration_person_assignment
): BOOLEAN;

LOCAL
    p_role : STRING;
END_LOCAL;
p_role := e\person_assignment.role.name;
CASE p_role OF
    'vendor' : IF SIZEOF(e.items) <> SIZEOF(QUERY ( x <* e.
        items | ('PLANT_SPATIAL_CONFIGURATION.DOCUMENT' IN TYPEOF(x)) ))
        THEN
            RETURN(FALSE);
        END_IF;
    'owner' : IF SIZEOF(e.items) <> SIZEOF(QUERY ( x <* e.
        items | (SIZEOF(['PLANT_SPATIAL_CONFIGURATION.SITE',
        'PLANT_SPATIAL_CONFIGURATION.DOCUMENT'] * TYPEOF(x)) = 1) ))
        THEN
            RETURN(FALSE);
        END_IF;
    'plant owner' : IF SIZEOF(e.items) <> SIZEOF(QUERY ( x <* e
        .items | ('PLANT_SPATIAL_CONFIGURATION.PLANT' IN TYPEOF(x)) ))
        THEN
            RETURN(FALSE);
        END_IF;
    'assessor' : IF SIZEOF(e.items) <> SIZEOF(QUERY ( x <* e.
        items | (('PLANT_SPATIAL_CONFIGURATION.' +
        'PRODUCT_DEFINITION_RELATIONSHIP') IN TYPEOF(x)) )) THEN
            RETURN(FALSE);
        END_IF;
    OTHERWISE : RETURN(TRUE);
END_CASE;
RETURN(TRUE);

END_FUNCTION; -- plant_spatial_configuration_person_correlation

```

```

FUNCTION scalar_times_vector(
    scalar: REAL;
    vec: vector_or_direction
): vector;

LOCAL
    v : direction;
    mag : REAL;
    result : vector;
END_LOCAL;
IF (NOT EXISTS(scalar)) OR (NOT EXISTS(vec)) THEN
    RETURN(?);
ELSE
    IF 'PLANT_SPATIAL_CONFIGURATION.VECTOR' IN TYPEOF(vec) THEN
        v := dummy_gri || direction(vec.orientation.direction_ratios);
    
```

```

    mag := scalar * vec.magnitude;
ELSE
    v := dummy_gri || direction(vec.direction_ratios);
    mag := scalar;
END_IF;
IF mag < 0 THEN
    REPEAT i := 1 TO SIZEOF(v.direction_ratios) BY 1;
        v.direction_ratios[i] := -v.direction_ratios[i];
    END_REPEAT;
    mag := -mag;
END_IF;
result := dummy_gri || vector(normalise(v),mag);
END_IF;
RETURN(result);

END_FUNCTION; -- scalar_times_vector

FUNCTION second_proj_axis(
    z_axis, x_axis, arg: direction
): direction;

LOCAL
    temp : vector;
    v : direction;
    y_axis : vector;
END_LOCAL;
IF NOT EXISTS(arg) THEN
    v := dummy_gri || direction([0,1,0]);
ELSE
    v := arg;
END_IF;
temp := scalar_times_vector(dot_product(v,z_axis),z_axis);
y_axis := vector_difference(v,temp);
temp := scalar_times_vector(dot_product(v,x_axis),x_axis);
y_axis := vector_difference(y_axis,temp);
y_axis := normalise(y_axis);
RETURN(y_axis.orientation);

END_FUNCTION; -- second_proj_axis

FUNCTION set_of_topology_reversed(
    a_set: set_of_reversible_topology_item
): set_of_reversible_topology_item;

LOCAL
    the_reverse : set_of_reversible_topology_item;
END_LOCAL;
the_reverse := [];
REPEAT i := 1 TO SIZEOF(a_set) BY 1;
    the_reverse := the_reverse + topology_reversed(a_set[i]);
END_REPEAT;
RETURN(the_reverse);

END_FUNCTION; -- set_of_topology_reversed

```

```

FUNCTION shell_reversed(
    a_shell: shell
): shell;
IF 'PLANT_SPATIAL_CONFIGURATION.OPEN_SHELL' IN TYPEOF(a_shell) THEN
    RETURN(open_shell_reversed(a_shell));
ELSE
    IF 'PLANT_SPATIAL_CONFIGURATION.CLOSED_SHELL' IN TYPEOF(a_shell) THEN
        RETURN(closed_shell_reversed(a_shell));
    ELSE
        RETURN(?);
    END_IF;
END_IF;

```

```

END_FUNCTION; -- shell_reversed

```

```

FUNCTION surface_weights_positive(
    b: rational_b_spline_surface
): BOOLEAN;

```

```

LOCAL
    result : BOOLEAN := TRUE;
END_LOCAL;
REPEAT i := 0 TO b.u_upper BY 1;
    REPEAT j := 0 TO b.v_upper BY 1;
        IF b.weights[i][j] <= 0 THEN
            result := FALSE;
            RETURN(result);
        END_IF;
    END_REPEAT;
END_REPEAT;
RETURN(result);

```

```

END_FUNCTION; -- surface_weights_positive

```

```

FUNCTION topology_reversed(
    an_item: reversible_topology
): reversible_topology;
IF 'PLANT_SPATIAL_CONFIGURATION.EDGE' IN TYPEOF(an_item) THEN
    RETURN(edge_reversed(an_item));
END_IF;
IF 'PLANT_SPATIAL_CONFIGURATION.PATH' IN TYPEOF(an_item) THEN
    RETURN(path_reversed(an_item));
END_IF;
IF 'PLANT_SPATIAL_CONFIGURATION.FACE_BOUND' IN TYPEOF(an_item) THEN
    RETURN(face_bound_reversed(an_item));
END_IF;
IF 'PLANT_SPATIAL_CONFIGURATION.FACE' IN TYPEOF(an_item) THEN
    RETURN(face_reversed(an_item));
END_IF;
IF 'PLANT_SPATIAL_CONFIGURATION.SHELL' IN TYPEOF(an_item) THEN

```

```

    RETURN(shell_reversed(an_item));
END_IF;
IF 'SET' IN TYPEOF(an_item) THEN
    RETURN(set_of_topology_reversed(an_item));
END_IF;
IF 'LIST' IN TYPEOF(an_item) THEN
    RETURN(list_of_topology_reversed(an_item));
END_IF;
RETURN(?);

END_FUNCTION; -- topology_reversed

FUNCTION using_items(
    item: founded_item_select;
    checked_items: SET OF founded_item_select
): SET OF founded_item_select;

LOCAL
    next_items    : SET OF founded_item_select;
    new_check_items : SET OF founded_item_select;
    result_items   : SET OF founded_item_select;
END_LOCAL;
result_items := [];
new_check_items := checked_items + item;
next_items := QUERY ( z < * bag_to_set(USEDIN(item,")) | ((
    'PLANT_SPATIAL_CONFIGURATION.REPRESENTATION_ITEM' IN TYPEOF(z)) OR
(
    'PLANT_SPATIAL_CONFIGURATION.FOUNDED_ITEM' IN TYPEOF(z)))) );
IF SIZEOF(next_items) > 0 THEN
    REPEAT i := 1 TO HIINDEX(next_items) BY 1;
        IF NOT (next_items[i] IN new_check_items) THEN
            result_items := result_items + next_items[i] + using_items(
                next_items[i],new_check_items);
        END_IF;
    END_REPEAT;
END_IF;
RETURN(result_items);

END_FUNCTION; -- using_items

FUNCTION using_representations(
    item: founded_item_select
): SET OF representation;

LOCAL
    results      : SET OF representation;
    intermediate_items : SET OF founded_item_select;
    result_bag    : BAG OF representation;
END_LOCAL;
results := [];
result_bag :=
USEDIN(item,'PLANT_SPATIAL_CONFIGURATION.REPRESENTATION.ITEMS');
IF SIZEOF(result_bag) > 0 THEN
    REPEAT i := 1 TO HIINDEX(result_bag) BY 1;

```

```

    results := results + result_bag[i];
  END_REPEAT;
END_IF;
intermediate_items := using_items(item,[]);
IF SIZEOF(intermediate_items) > 0 THEN
  REPEAT i := 1 TO HIINDEX(intermediate_items) BY 1;
    result_bag := USEDIN(intermediate_items[i],
      'PLANT_SPATIAL_CONFIGURATION.REPRESENTATION.ITEMS');
    IF SIZEOF(result_bag) > 0 THEN
      REPEAT j := 1 TO HIINDEX(result_bag) BY 1;
        results := results + result_bag[j];
      END_REPEAT;
    END_IF;
  END_REPEAT;
END_IF;
RETURN(results);

```

```
END_FUNCTION; -- using_representations
```

```

FUNCTION valid_advanced_csg_tree(
  tree_element: boolean_operand
): BOOLEAN;
IF SIZEOF(TYPEOF(tree_element) * ['PLANT_SPATIAL_CONFIGURATION.BLOCK',
  'PLANT_SPATIAL_CONFIGURATION.TORUS',
  'PLANT_SPATIAL_CONFIGURATION.RIGHT_CIRCULAR_CYLINDER',
  'PLANT_SPATIAL_CONFIGURATION.SPHERE',
  'PLANT_SPATIAL_CONFIGURATION.RIGHT_CIRCULAR_CONE',
  'PLANT_SPATIAL_CONFIGURATION.ECCENTRIC_CONE',
  'PLANT_SPATIAL_CONFIGURATION.PLANT_DESIGN_CSG_PRIMITIVE',
  'PLANT_SPATIAL_CONFIGURATION.CYCLIDE_SEGMENT_SOLID',
  'PLANT_SPATIAL_CONFIGURATION.RECTANGULAR_PYRAMID',
  'PLANT_SPATIAL_CONFIGURATION.EXTRUDED_AREA_SOLID',
  'PLANT_SPATIAL_CONFIGURATION.REVOLVED_AREA_SOLID',
  'PLANT_SPATIAL_CONFIGURATION.HALF_SPACE_SOLID']) = 1 THEN
  RETURN(TRUE);
ELSE
  IF 'PLANT_SPATIAL_CONFIGURATION.BOOLEAN_RESULT' IN TYPEOF(
    tree_element) THEN
    IF NOT (tree_element\boolean_result.operator IN [boolean_operator.
      union,boolean_operator.difference]) THEN
      RETURN(FALSE);
    END_IF;
  IF 'PLANT_SPATIAL_CONFIGURATION.HALF_SPACE_SOLID' IN TYPEOF(
    tree_element\boolean_result.first_operand) THEN
    IF 'PLANT_SPATIAL_CONFIGURATION.ELEMENTARY_SURFACE' IN TYPEOF(
      tree_element\boolean_result.first_operand\half_space_solid.
      base_surface) THEN
      IF 'PLANT_SPATIAL_CONFIGURATION.HALF_SPACE_SOLID' IN TYPEOF(
        tree_element\boolean_result.second_operand) THEN
        IF 'PLANT_SPATIAL_CONFIGURATION.ELEMENTARY_SURFACE' IN
          TYPEOF(tree_element\boolean_result.second_operand\

```

```

        half_space_solid.base_surface) THEN
        RETURN(TRUE);
    ELSE
        RETURN(FALSE);
    END_IF;
ELSE
    RETURN(valid_advanced_csg_tree(tree_element\boolean_result.
        second_operand));
END_IF;
ELSE
    RETURN(FALSE);
END_IF;
ELSE
    IF 'PLANT_SPATIAL_CONFIGURATION.HALF_SPACE_SOLID' IN TYPEOF(
        tree_element\boolean_result.second_operand) THEN
        IF 'PLANT_SPATIAL_CONFIGURATION.ELEMENTARY_SURFACE' IN TYPEOF(
            tree_element\boolean_result.second_operand\half_space_solid
                .base_surface) THEN
            RETURN(valid_advanced_csg_tree(tree_element\boolean_result.
                first_operand));
        ELSE
            RETURN(FALSE);
        END_IF;
    ELSE
        RETURN(valid_advanced_csg_tree(tree_element\boolean_result.
            first_operand) AND valid_advanced_csg_tree(tree_element\
                boolean_result.second_operand));
    END_IF;
END_IF;
END_IF;
END_IF;
RETURN(FALSE);

END_FUNCTION; -- valid_advanced_csg_tree

FUNCTION valid_calendar_date(
    date: calendar_date
): LOGICAL;
CASE date.month_component OF
    1 : RETURN((1 <= date.day_component) AND (date.day_component
        <= 31));
    2 : BEGIN
        IF leap_year(date.year_component) THEN
            RETURN((1 <= date.day_component) AND (date.day_component <= 29));
        ELSE
            RETURN((1 <= date.day_component) AND (date.day_component <= 28));
        END_IF;
    END;
    3 : RETURN((1 <= date.day_component) AND (date.day_component
        <= 31));
    4 : RETURN((1 <= date.day_component) AND (date.day_component
        <= 30));
    5 : RETURN((1 <= date.day_component) AND (date.day_component
        <= 31));
END_CASE;

```

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```

6 : RETURN((1 <= date.day_component) AND (date.day_component
    <= 30));
7 : RETURN((1 <= date.day_component) AND (date.day_component
    <= 31));
8 : RETURN((1 <= date.day_component) AND (date.day_component
    <= 31));
9 : RETURN((1 <= date.day_component) AND (date.day_component
    <= 30));
10 : RETURN((1 <= date.day_component) AND (date.
    day_component <= 31));
11 : RETURN((1 <= date.day_component) AND (date.
    day_component <= 30));
12 : RETURN((1 <= date.day_component) AND (date.
    day_component <= 31));
END_CASE;
RETURN(FALSE);

```

```
END_FUNCTION; -- valid_calendar_date
```

```

FUNCTION valid_measure_value
(m : measure_value) : BOOLEAN;
IF ('REAL' IN TYPEOF (m)) THEN
RETURN (m > 0.0);
ELSE
IF ('INTEGER' IN TYPEOF (m)) THEN
RETURN (m > 0);
ELSE
RETURN (TRUE);
END_IF;
END_IF;
END_FUNCTION; -- valid_measure_value

```

```

FUNCTION valid_time(
    time: local_time
): BOOLEAN;
IF EXISTS(time.second_component) THEN
RETURN(EXISTS(time.minute_component));
ELSE
RETURN(TRUE);
END_IF;

```

```
END_FUNCTION; -- valid_time
```

```

FUNCTION valid_units(
    m: measure_with_unit
): BOOLEAN;
IF 'PLANT_SPATIAL_CONFIGURATION.LENGTH_MEASURE' IN
TYPEOF(m.value_component)
THEN
IF derive_dimensional_exponents(m.unit_component) <>
dimensional_exponents(1,0,0,0,0,0) THEN

```

```

    RETURN(FALSE);
  END_IF;
END_IF;
IF 'PLANT_SPATIAL_CONFIGURATION.MASS_MEASURE' IN
TYPEOF(m.value_component)
THEN
  IF derive_dimensional_exponents(m.unit_component) <>
    dimensional_exponents(0,1,0,0,0,0) THEN
    RETURN(FALSE);
  END_IF;
END_IF;
IF 'PLANT_SPATIAL_CONFIGURATION.TIME_MEASURE' IN
TYPEOF(m.value_component)
THEN
  IF derive_dimensional_exponents(m.unit_component) <>
    dimensional_exponents(0,0,1,0,0,0) THEN
    RETURN(FALSE);
  END_IF;
END_IF;
IF 'PLANT_SPATIAL_CONFIGURATION.ELECTRIC_CURRENT_MEASURE' IN
TYPEOF(m.
  value_component) THEN
  IF derive_dimensional_exponents(m.unit_component) <>
    dimensional_exponents(0,0,0,1,0,0) THEN
    RETURN(FALSE);
  END_IF;
END_IF;
IF
'PLANT_SPATIAL_CONFIGURATION.THERMODYNAMIC_TEMPERATURE_MEASURE'
IN
  TYPEOF(m.value_component) THEN
  IF derive_dimensional_exponents(m.unit_component) <>
    dimensional_exponents(0,0,0,0,1,0) THEN
    RETURN(FALSE);
  END_IF;
END_IF;
IF 'PLANT_SPATIAL_CONFIGURATION.CELSIUS_TEMPERATURE_MEASURE' IN
TYPEOF(m.
  value_component) THEN
  IF derive_dimensional_exponents(m.unit_component) <>
    dimensional_exponents(0,0,0,0,1,0) THEN
    RETURN(FALSE);
  END_IF;
END_IF;
IF 'PLANT_SPATIAL_CONFIGURATION.AMOUNT_OF_SUBSTANCE_MEASURE' IN
TYPEOF(m.
  value_component) THEN
  IF derive_dimensional_exponents(m.unit_component) <>
    dimensional_exponents(0,0,0,0,0,1) THEN
    RETURN(FALSE);
  END_IF;
END_IF;
IF 'PLANT_SPATIAL_CONFIGURATION.LUMINOUS_INTENSITY_MEASURE' IN
TYPEOF(m.
  value_component) THEN
  IF derive_dimensional_exponents(m.unit_component) <>
    dimensional_exponents(0,0,0,0,0,1) THEN
    RETURN(FALSE);
  END_IF;
END_IF;

```

```

        value_component) THEN
    IF derive_dimensional_exponents(m.unit_component) <>
        dimensional_exponents(0,0,0,0,0,0,1) THEN
        RETURN(FALSE);
    END_IF;
END_IF;
IF 'PLANT_SPATIAL_CONFIGURATION.PLANE_ANGLE_MEASURE' IN
    TYPEOF(m.value_component)
    THEN
    IF derive_dimensional_exponents(m.unit_component) <>
        dimensional_exponents(0,0,0,0,0,0,0) THEN
        RETURN(FALSE);
    END_IF;
END_IF;
IF 'PLANT_SPATIAL_CONFIGURATION.SOLID_ANGLE_MEASURE' IN
    TYPEOF(m.value_component)
    THEN
    IF derive_dimensional_exponents(m.unit_component) <>
        dimensional_exponents(0,0,0,0,0,0,0) THEN
        RETURN(FALSE);
    END_IF;
END_IF;
IF 'PLANT_SPATIAL_CONFIGURATION.AREA_MEASURE' IN
    TYPEOF(m.value_component)
    THEN
    IF derive_dimensional_exponents(m.unit_component) <>
        dimensional_exponents(2,0,0,0,0,0,0) THEN
        RETURN(FALSE);
    END_IF;
END_IF;
IF 'PLANT_SPATIAL_CONFIGURATION.VOLUME_MEASURE' IN
    TYPEOF(m.value_component)
    THEN
    IF derive_dimensional_exponents(m.unit_component) <>
        dimensional_exponents(3,0,0,0,0,0,0) THEN
        RETURN(FALSE);
    END_IF;
END_IF;
IF 'PLANT_SPATIAL_CONFIGURATION.RATIO_MEASURE' IN
    TYPEOF(m.value_component)
    THEN
    IF derive_dimensional_exponents(m.unit_component) <>
        dimensional_exponents(0,0,0,0,0,0,0) THEN
        RETURN(FALSE);
    END_IF;
END_IF;
IF 'PLANT_SPATIAL_CONFIGURATION.POSITIVE_LENGTH_MEASURE' IN
    TYPEOF(m.
        value_component) THEN
    IF derive_dimensional_exponents(m.unit_component) <>
        dimensional_exponents(1,0,0,0,0,0,0) THEN

```

```

    RETURN(FALSE);
  END_IF;
END_IF;
IF 'PLANT_SPATIAL_CONFIGURATION.POSITIVE_PLANE_ANGLE_MEASURE' IN
TYPEOF(m.
  value_component) THEN
  IF derive_dimensional_exponents(m.unit_component) <>
    dimensional_exponents(0,0,0,0,0,0) THEN
    RETURN(FALSE);
  END_IF;
END_IF;
RETURN(TRUE);

```

```
END_FUNCTION; -- valid_units
```

```

FUNCTION vector_difference(
  arg1, arg2: vector_or_direction
): vector;

```

```
LOCAL
```

```

  ndim : INTEGER;
  mag2 : REAL;
  mag1 : REAL;
  mag : REAL;
  res : direction;
  vec1 : direction;
  vec2 : direction;
  result : vector;

```

```
END_LOCAL;
```

```

IF (NOT EXISTS(arg1)) OR (NOT EXISTS(arg2)) OR (arg1.dim <> arg2.dim)
  THEN
    RETURN(?);

```

```
ELSE
```

```
BEGIN
```

```

  IF 'PLANT_SPATIAL_CONFIGURATION.VECTOR' IN TYPEOF(arg1) THEN
    mag1 := arg1.magnitude;
    vec1 := arg1.orientation;

```

```
ELSE
```

```

  mag1 := 1;
  vec1 := arg1;

```

```
END_IF;
```

```
IF 'PLANT_SPATIAL_CONFIGURATION.VECTOR' IN TYPEOF(arg2) THEN
```

```

  mag2 := arg2.magnitude;
  vec2 := arg2.orientation;

```

```
ELSE
```

```

  mag2 := 1;
  vec2 := arg2;

```

```
END_IF;
```

```
vec1 := normalise(vec1);
```

```
vec2 := normalise(vec2);
```

```
ndim := SIZEOF(vec1.direction_ratios);
```

```
mag := 0;
```

```
res := dummy_gri || direction(vec1.direction_ratios);
```

```
REPEAT i := 1 TO ndim BY 1;
```

```
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```

```

        res.direction_ratios[i] := (mag1 * vec1.direction_ratios[i]) + (
            mag2 * vec2.direction_ratios[i]);
        mag := mag + (res.direction_ratios[i] * res.direction_ratios[i]);
    END_REPEAT;
    IF mag > 0 THEN
        result := dummy_gri || vector(res,SQRT(mag));
    ELSE
        result := dummy_gri || vector(vec1,0);
    END_IF;
END;
END_IF;
RETURN(result);

END_FUNCTION; -- vector_difference

FUNCTION vertex_point_pcurves (a_vertex : vertex_point;
    the_degenerates : SET OF evaluated_degenerate_pcurve)
    : SET OF degenerate_pcurve;
LOCAL
    a_point : point;
    result : SET OF degenerate_pcurve;
END_LOCAL;
a_point := a_vertex.vertex_geometry;
result := [];
IF 'PLANT_SPATIAL_CONFIGURATION.DEGENERATE_PCURVE' IN
TYPEOF(a_point) THEN
    result := result + a_point;
ELSE
    REPEAT j := 1 TO SIZEOF(the_degenerates);
        IF (the_degenerates[j].equivalent_point :=: a_point) THEN
            result := result + the_degenerates[j];
        END_IF;
    END_REPEAT;
END_IF;

    RETURN (RESULT);
END_FUNCTION;

END_SCHEMA; -- plant_spatial_configuration

```

## Annex B

(normative)

### AIM short names of entities

Table B.1 provides the short names of entities specified in the AIM of this part of ISO 10303. Requirements on the use of the short names are found in the implementation methods included in ISO 10303.

**Table B.1 - Short names of entities**

<u>Entity name</u>	<u>Short name</u>
ACTION	ACTION
ACTION_ASSIGNMENT	ACTASS
ACTION_DIRECTIVE	ACTDRC
ACTION_METHOD	ACTMTH
ACTION_METHOD_RELATIONSHIP	ACMTRL
ACTION_RELATIONSHIP	ACTRLT
ACTION_REQUEST_ASSIGNMENT	ACRQAS
ACTION_REQUEST_SOLUTION	ACRQSL
ACTION_REQUEST_STATUS	ACRQST
ACTION_STATUS	ACTSTT
AMOUNT_OF_SUBSTANCE_MEASURE_WITH_UNIT	AOSMWU
AMOUNT_OF_SUBSTANCE_UNIT	AOSU
ANGULAR_LOCATION	ANGLCT
APPLICATION_CONTEXT	APPCNT
APPLICATION_CONTEXT_ELEMENT	APCNEL
APPLICATION_PROTOCOL_DEFINITION	APPRDF
APPLIED_ACTION_REQUEST_ASSIGNMENT	AARA
APPLIED_APPROVAL_ASSIGNMENT	APAPAS
APPLIED_CLASSIFICATION_ASSIGNMENT	APCLAS
APPLIED_DATE_AND_TIME_ASSIGNMENT	ADATA
APPLIED_DATE_ASSIGNMENT	APDTAS
APPLIED_DOCUMENT_REFERENCE	APDCRF
APPLIED_IDENTIFICATION_ASSIGNMENT	APIDAS
APPROVAL	APPRVL
APPROVAL_ASSIGNMENT	APPASS
APPROVAL_DATE_TIME	APDTTM
APPROVAL_PERSON_ORGANIZATION	APPROR
APPROVAL_ROLE	APPRL
APPROVAL_STATUS	APPSTT
ASSEMBLY_COMPONENT_USAGE	ASCMUS
AXIS1_PLACEMENT	AX1PLC
AXIS2_PLACEMENT_2D	A2PL2D
AXIS2_PLACEMENT_3D	A2PL3D
B_SPLINE_CURVE	BSPCR
B_SPLINE_CURVE_WITH_KNOTS	BSCWK
B_SPLINE_SURFACE	BSPSR
<u>Entity name</u>	<u>Short name</u>
B_SPLINE_SURFACE_WITH_KNOTS	BSSWK

BEZIER_CURVE	BZRCRV
BEZIER_SURFACE	BZRSRF
BLANK_FITTING_CLASS	BLFTCL
BLOCK	BLOCK
BOLT_AND_NUT_COMPONENT_CLASS	BANCC
BOLT_AND_NUT_COMPONENT_DEFINITION	BANCD
BOLT_AND_NUT_SET_DEFINITION	BANSD
BOOLEAN_RESULT	BLNRSL
BOUNDARY_CURVE	BNDCR
BOUNDED_	BNDCRV
BOUNDED_PCURVE	BNDPCR
BOUNDED_SURFACE	BNDSRF
BOUNDED_SURFACE_CURVE	BNSRCR
BREP_WITH_VOIDS	BRWTV
CABLEWAY_COMPONENT_CLASS	CBCMCL
CABLEWAY_COMPONENT_DEFINITION	CBCMDF
CABLEWAY_CONNECTOR_CLASS	CBCNCL
CABLEWAY_SYSTEM	CBLSYS
CALENDAR_DATE	CLNDT
CARTESIAN_POINT	CRTPNT
CARTESIAN_TRANSFORMATION_OPERATOR	CRTROP
CARTESIAN_TRANSFORMATION_OPERATOR_3D	CTO3
CATALOGUE	CTLG
CATALOGUE_CONNECTOR	CTLCNN
CATALOGUE_ITEM	CTLITM
CENTRE_OF_SYMMETRY	CNOFSY
CHANGE_ACTION	CHNACT
CHANGE_ITEM_ID_ASSIGNMENT	CIIA
CHANGE_LIFE_CYCLE_STAGE_ASSIGNMENT	CLCSA
CHARACTERIZED_OBJECT	CHROBJ
CIRCLE	CIRCLE
CLASSIFICATION_ASSIGNMENT	CLSASS
CLASSIFICATION_ROLE	CLSRL
CLOSED_SHELL	CLSSHL
COLOUR	COLOUR
COLOUR_RGB	CLRRGB
COLOUR_SPECIFICATION	CLRSPC
COMPOSITE_CURVE	CMPCRV
COMPOSITE_CURVE_ON_SURFACE	CCOS
COMPOSITE_CURVE_SEGMENT	CMCRSG
CONIC	CONIC
CONICAL_SURFACE	CNCSRF
CONNECTED_FACE_SET	CNFCST
CONNECTION_FUNCTIONAL_CLASS	CNFNCL
CONNECTION_MATERIAL_DEFINITION	CNMTDF
CONNECTION_MOTION_CLASS	CNMTCL
CONNECTION_NODE	CNNND
<b><u>Entity name</u></b>	<b><u>Short name</u></b>
CONNECTOR_END_TYPE_CLASS	CETO
CONTEXT_DEPENDENT_UNIT	CNDPUN

CONVERSION_BASED_UNIT	CNBSUN
COORDINATED_UNIVERSAL_TIME_OFFSET	CUTO
CSG_SOLID	CSGSLD
CURVE	CURVE
CURVE_BOUNDED_SURFACE	CRBNSR
CURVE_REPLICA	CRVRPL
CYCLIDE_SEGMENT_SOLID	CYSGSL
CYLINDRICAL_SURFACE	CYLSRF
DATA_ENVIRONMENT	DTENV
DATE	DATE
DATE_AND_TIME	DTANTM
DATE_AND_TIME_ASSIGNMENT	DATA
DATE_ASSIGNMENT	DTASS
DATE_ROLE	DTRL
DATE_TIME_ROLE	DTTMRL
DEFINITIONAL_REPRESENTATION	DFNRPR
DEGENERATE_PCURVE	DGNPCR
DEGENERATE_TOROIDAL_SURFACE	DGTRSR
DERIVED_SHAPE_ASPECT	DRSHAS
DERIVED_UNIT	DRVUNT
DERIVED_UNIT_ELEMENT	DRUNEL
DESCRIPTION_ATTRIBUTE	DSCATT
DESCRIPTIVE_COLOUR	DSCCLR
DESCRIPTIVE_REPRESENTATION_ITEM	DSRPIT
DESIGN_PROJECT	DSGPRJ
DESIGN_PROJECT_ASSIGNMENT	DSPRAS
DIMENSIONAL_CHARACTERISTIC_REPRESENTATION	DMCHRP
DIMENSIONAL_EXPONENTS	DMNEXP
DIMENSIONAL_LOCATION	DMNLCT
DIMENSIONAL_SIZE	DMNSZ
DIRECTED_ACTION	DRCACT
DIRECTION	DRCTN
DOCUMENT	DCMNT
DOCUMENT_REFERENCE	DCMRFR
DOCUMENT_RELATIONSHIP	DCMRLT
DOCUMENT_REPRESENTATION_TYPE	DCRPTY
DOCUMENT_TYPE	DCMTYP
DOCUMENT_USAGE_CONSTRAINT	DCUSCN
DUCTING_SYSTEM	DCTSYS
ECCENTRIC_CONE	ECCCN
EDGE	EDGE
EDGE_CURVE	EDGCRV
EDGE_LOOP	EDGLP
ELBOW_FITTING_CLASS	ELFTCL
ELECTRIC_CURRENT_MEASURE_WITH_UNIT	ECMWU
ELECTRIC_CURRENT_UNIT	ELCRUN
<b><u>Entity name</u></b>	<b><u>Short name</u></b>
ELECTRICAL_CONNECTOR_CLASS	ELCNCL
ELECTRICAL_SYSTEM	ELCSYS
ELEMENTARY_SURFACE	ELMSRF
ELLIPSE	ELLPS
ELLIPSOID	ELLPSD
EVALUATED_DEGENERATE_PCURVE	EVDGPC

EXECUTED_ACTION	EXCACT
EXTERNAL_SOURCE	EXTSRC
EXTERNALLY_DEFINED_CLASS	EXD0
EXTERNALLY_DEFINED_DOCUMENT	EXDFDC
EXTERNALLY_DEFINED_ITEM	EXDFIT
EXTERNALLY_DEFINED_ITEM_RELATIONSHIP	EDIR
EXTERNALLY_DEFINED_PLANT_ITEM_DEFINITION	EDPID
EXTERNALLY_DEFINED_REPRESENTATION_ITEM	EDRI
EXTRUDED_AREA_SOLID	EXARSL
EXTRUDED_FACE_SOLID	EXFCSL
FACE	FACE
FACE_BOUND	FCBND
FACE_OUTER_BOUND	FCOTBN
FACE_SURFACE	FCSRF
FACETED_BREP	FCTBR
FLANGE_FITTING_CLASS	FLFTCL
FLANGE_FITTING_NECK_TYPE_CLASS	FFNTC
FOUNDED_ITEM	FNDITM
FUNCTIONALLY_DEFINED_TRANSFORMATION	FNDFTR
GEOMETRIC_CURVE_SET	GMCRST
GEOMETRIC_REPRESENTATION_CONTEXT	GMRPCN
GEOMETRIC_REPRESENTATION_ITEM	GMRPIT
GEOMETRIC_SET	GMTST
GEOMETRIC_SET_REPLICA	GMSTRP
GLOBAL_UNCERTAINTY_ASSIGNED_CONTEXT	GC
GLOBAL_UNIT_ASSIGNED_CONTEXT	GUAC
GROUP	GROUP
GROUP_ASSIGNMENT	GRPASS
GROUP_RELATIONSHIP	GRPRLT
HALF_SPACE_SOLID	HLSPSL
HEAT_TRACING_REPRESENTATION	HTTRRP
HVAC_BRANCH_CONNECTION	HVBRCN
HVAC_COMPONENT_DEFINITION	HVCMDF
HVAC_CONNECTOR	HVCCNN
HVAC_FITTING_CLASS	HVFTCL
HVAC_PLANT_ITEM_BRANCH_CONNECTION	HPIBC
HVAC_PLANT_ITEM_CONNECTION	HPIC
HVAC_CROSS_SECTION	HVCRSC
HVAC_SECTION_SEGMENT_DEFINITION	HSSD
HVAC_SECTION_SEGMENT_TERMINATION	HSST
HVAC_SYSTEM	HVCSYS
HVAC_SYSTEM_SECTION_DEFINITION	HSS0
<b><u>Entity name</u></b>	<b><u>Short name</u></b>
HVAC_TERMINATION_CONNECTION	HVTRCN
HYBRID_SHAPE_REPRESENTATION	HYSHRP
HYPERBOLA	HYPRBL
ID_ATTRIBUTE	IDATT
IDENTIFICATION_ASSIGNMENT	IDNASS
IDENTIFICATION_ROLE	IDNRL
INLINE_EQUIPMENT	INLEQP

INSTRUMENTATION_AND_CONTROL_SYSTEM	IACS
INTERFERING_SHAPE_ELEMENT	INSHEL
INTERSECTION_CURVE	INTCRV
ITEM_IDENTIFIED_REPRESENTATION_USAGE	IIRU
KNOWN_SOURCE	KNWSRC
LENGTH_MEASURE_WITH_UNIT	LMWU
LENGTH_UNIT	LNGUNT
LINE	LINE
LINE_BRANCH_CONNECTION	LNBRCN
LINE_LESS_PIPING_SYSTEM	LLPS
LINE_PLANT_ITEM_BRANCH_CONNECTION	LPIBC
LINE_PLANT_ITEM_CONNECTION	LPIC
LINE_TERMINATION_CONNECTION	LNTRCN
LOCAL_TIME	LCLTM
LOOP	LOOP
LUMINOUS_INTENSITY_MEASURE_WITH_UNIT	LIMWU
LUMINOUS_INTENSITY_UNIT	LMINUN
MAKE_FROM_USAGE_OPTION	MFUO
MANIFOLD_SOLID_BREP	MNSLBR
MAPPED_ITEM	MPPITM
MASS_MEASURE_WITH_UNIT	MMWU
MASS_UNIT	MSSUNT
MATERIAL_DESIGNATION	MTRDSG
MATERIAL_DESIGNATION_CHARACTERIZATION	MTDSCH
MATERIAL_PROPERTY	MTRPRP
MATERIAL_PROPERTY_REPRESENTATION	MTPRRP
MEASURE_REPRESENTATION_ITEM	MSRPIT
MEASURE_WITH_UNIT	MSWTUN
NAME_ASSIGNMENT	NMASS
NAME_ATTRIBUTE	NMATT
NAMED_UNIT	NMDUNT
OBJECT_ROLE	OBJRL
OFFSET_CURVE_2D	OF2CR2D
OFFSET_CURVE_3D	OF3CR3D
OFFSET_SURFACE	OFFSRF
OPEN_SHELL	OPNSHL
ORGANIZATION	ORGNZT
ORGANIZATION_ASSIGNMENT	ORGASS
ORGANIZATION_ROLE	ORGRL
ORGANIZATIONAL_PROJECT	ORGPRJ
ORIENTED_CLOSED_SHELL	ORCLSH
<b><u>Entity name</u></b>	<b><u>Short name</u></b>
ORIENTED_EDGE	ORNEDG
ORIENTED_FACE	ORNFC
ORIENTED_OPEN_SHELL	OROPSH
ORIENTED_PATH	ORNPTH
OUTER_BOUNDARY_CURVE	OTBNCR
PARABOLA	PRBL
PARAMETRIC_REPRESENTATION_CONTEXT	PRRPCN
PATH	PATH
PCURVE	PCURVE
PERSON	PERSON
PERSON_AND_ORGANIZATION	PRANOR

PERSON_AND_ORGANIZATION_ASSIGNMENT	PAOA
PERSON_AND_ORGANIZATION_ROLE	PAOR
PERSON_ASSIGNMENT	PRSASS
PERSON_ROLE	PRSRL
PIPE_CLASS	PPCLS
PIPE_CLOSURE_FITTING_CLASS	PCFC
PIPING_COMPONENT_CLASS	PPCMCL
PIPING_COMPONENT_DEFINITION	PPCMDF
PIPING_CONNECTOR_CLASS	PPC0
PIPING_SPOOL_DEFINITION	PPSPDF
PIPING_SUPPORT_DEFINITION	PPS0
PIPING_SUPPORT_FITTING_CLASS	PSFC
PIPING_SYSTEM	PPNSYS
PLACEMENT	PLCMNT
PLANE	PLANE
PLANE_ANGLE_MEASURE_WITH_UNIT	PAMWU
PLANE_ANGLE_UNIT	PLANUN
PLANT	PLANT
PLANT_CSG_SHAPE_REPRESENTATION	PCSR
PLANT_DESIGN_CSG_PRIMITIVE	PDCP
PLANT_ITEM_CONNECTION	PLITCN
PLANT_ITEM_CONNECTOR	PLI0
PLANT_ITEM_INTERFERENCE	PLITIN
PLANT_ITEM_ROUTE	PLITRT
PLANT_ITEM_WEIGHT_REPRESENTATION	PIWR
PLANT_LINE_DEFINITION	PLLNDF
PLANT_LINE_SEGMENT_DEFINITION	PLSD
PLANT_LINE_SEGMENT_TERMINATION	PLST
PLANT_SPATIAL_CONFIGURATION_CHANGE_ASSIGNMENT	PSCCA
PLANT_SPATIAL_CONFIGURATION_ORGANIZATION_ASSIGNMENT	PSCOA
PLANT_SPATIAL_CONFIGURATION_PERSON_AND_ORGANIZATION_ASSIGNMENT	PSCPAO
PLANT_SPATIAL_CONFIGURATION_PERSON_ASSIGNMENT	PSCPA
POINT	POINT
POINT_ON_CURVE	PNONCR
POINT_ON_SURFACE	PNONSR
POINT_REPLICA	PNTRPL
<b><u>Entity name</u></b>	<b><u>Short name</u></b>
POLY_LOOP	PLYLP
POLYLINE	PLYLN
PRE_DEFINED_ITEM	PRDFIT
PRECISION_QUALIFIER	PRCQLF
PRESENTATION_LAYER_ASSIGNMENT	PRLYAS
PROCESS_CAPABILITY	PRCCPB
PRODUCT	PRDCT
PRODUCT_CONTEXT	PRDCNT
PRODUCT_DEFINITION	PRDDFN
PRODUCT_DEFINITION_CONTEXT	PRDFCN
PRODUCT_DEFINITION_FORMATION	PRDFFR
PRODUCT_DEFINITION_FORMATION_RELATIONSHIP	PDFR

PRODUCT_DEFINITION_FORMATION_WITH_SPECIFIED_SOURCE	PDFWSS
PRODUCT_DEFINITION_RELATIONSHIP	PRDFRL
PRODUCT_DEFINITION_SHAPE	PRDFSH
PRODUCT_DEFINITION_SUBSTITUTE	PRDFSB
PRODUCT_DEFINITION_USAGE	PRDFUS
PRODUCT_DEFINITION_WITH_ASSOCIATED_DOCUMENTS	PDWAD
PRODUCT_MATERIAL_COMPOSITION_RELATIONSHIP	PMCR
PROPERTY_DEFINITION	PRPDFN
PROPERTY_DEFINITION_RELATIONSHIP	PRDFR
PROPERTY_DEFINITION_REPRESENTATION	PRDFRP
PURCHASE_ASSIGNMENT	PRCASS
QUALIFIED_REPRESENTATION_ITEM	QLRPIT
QUASI_UNIFORM_CURVE	QSUNCR
QUASI_UNIFORM_SURFACE	QSUNSR
RATIO_MEASURE_WITH_UNIT	RMWU
RATIO_UNIT	RTUNT
RATIONAL_B_SPLINE_CURVE	RBSC
RATIONAL_B_SPLINE_SURFACE	RBSS
RECTANGULAR_COMPOSITE_SURFACE	RCCMSR
RECTANGULAR_PYRAMID	RCTPYR
RECTANGULAR_TRIMMED_SURFACE	RCTRSR
REDUCER_FITTING_CLASS	RDFTCL
REFERENCE_GEOMETRY	RFRGMT
REINFORCING_COMPONENT_DEFINITION	RNCMDF
REPARAMETRISED_COMPOSITE_CURVE_SEGMENT	RCCS
REPRESENTATION	RPRSNT
REPRESENTATION_CONTEXT	RPRCNT
REPRESENTATION_ITEM	RPRITM
REPRESENTATION_ITEM_RELATIONSHIP	RPITRL
REPRESENTATION_MAP	RPRMP
REQUIRED_MATERIAL_PROPERTY	RQMTPR
RESERVED_SPACE	RSRSPC
REVOLVED_AREA_SOLID	RVARSL
REVOLVED_FACE_SOLID	RVFCSL
RIGHT_ANGULAR_WEDGE	RGANWD
RIGHT_CIRCULAR_CONE	RGCRCN
<b><u>Entity name</u></b>	<b><u>Short name</u></b>
RIGHT_CIRCULAR_CYLINDER	RGCRCY
ROLE_ASSOCIATION	RLASS
SEAM_CURVE	SMCRV
SHAPE_ASPECT	SHPASP
SHAPE_ASPECT_DERIVING_RELATIONSHIP	SADR
SHAPE_ASPECT_RELATIONSHIP	SHASRL
SHAPE_DEFINITION_REPRESENTATION	SHDFRP
SHAPE_DIMENSION_REPRESENTATION	SHDMRP
SHAPE_REPRESENTATION	SHPRPR
SHELL_BASED_WIREFRAME_MODEL	SBWM
SI_UNIT	SUNT
SITE	SITE
SITE_BUILDING	STBLD
SITE_FEATURE	STFTR
SITE_REPRESENTATION	STRPR
SITED_PLANT	STDPLN

SOLID_ANGLE_MEASURE_WITH_UNIT	SAMWU
SOLID_ANGLE_UNIT	SLANUN
SOLID_MODEL	SLDMDL
SPACER_FITTING_CLASS	SPFTCL
SPECIALTY_ITEM_CLASS	SPITCL
SPHERE	SPHERE
SPHERICAL_SURFACE	SPHSRF
STREAM_DESIGN_CASE	STDSCS
STREAM_PHASE	STRPHS
STRUCTURAL_LOAD_CONNECTOR_CLASS	SLCC
STRUCTURAL_SYSTEM	STRSYS
SUPPORT_CONSTRAINT_REPRESENTATION	SPCNRP
SURFACE	SRFC
SURFACE_CURVE	SRFCRV
SURFACE_OF_LINEAR_EXTRUSION	SL
SURFACE_OF_REVOLUTION	SROFRV
SURFACE_PATCH	SRFPTC
SURFACE_REPLICA	SRFRPL
SWAGE_FITTING_CLASS	SWFTCL
SWEPT_AREA_SOLID	SWARSL
SWEPT_FACE_SOLID	SWFCSL
SWEPT_SURFACE	SWPSRF
SYMMETRIC_SHAPE_ASPECT	SYSHAS
SYSTEM_CLASS	SYSCLS
SYSTEM_SPACE	SYSSPC
THERMODYNAMIC_TEMPERATURE_MEASURE_WITH_UNIT	TTMWU
THERMODYNAMIC_TEMPERATURE_UNIT	THTMUN
TIME_MEASURE_WITH_UNIT	TMWU
TIME_UNIT	TMUNT
TOPOLOGICAL_REPRESENTATION_ITEM	TPRPIT
TOROIDAL_SURFACE	TRDSRF
TORUS	TORUS
<b><u>Entity name</u></b>	<b><u>Short name</u></b>
TRIMMED_CURVE	TRMCRV
TYPE_QUALIFIER	TYPQLF
UNCERTAINTY_MEASURE_WITH_UNIT	UMWU
UNIFORM_CURVE	UNFCRV
UNIFORM_SURFACE	UNFSRF
VALVE_CLASS	VLVCLS
VECTOR	VECTOR
VERSIONED_ACTION_REQUEST	VRACRQ
VERTEX	VERTEX
VERTEX_LOOP	VRTLP
VERTEX_POINT	VRTPNT
VERTEX_SHELL	VRTSHL
WIRE_SHELL	WRSHL

## **Annex C**

(normative)

### **Implementation method-specific requirements**

The implementation method defines what types of exchange behaviour are required with respect to this part of ISO 10303. Conformance to this part of ISO 10303 shall be realized in an exchange structure. The file format shall be encoded according to the syntax and EXPRESS language mapping defined in ISO 10303-21 and the AIM defined in annex A of this part of ISO 10303. The header of the exchange structure shall identify the use of this part of ISO 10303 by the schema name 'plant\_spatial\_configuration'.

## Annex D

(normative)

### Protocol Information Conformance Statement proforma

This clause lists the optional elements of this part of ISO 10303. An implementation may chose to support any combination of this optional elements. However, certain combinations of options are likely to be implemented together. These combinations are called conformance classes and are described in the subclauses of this annex.

This annex is in the form of a questionnaire. This questionnaire is intended to be filled out by the implementor and may be used in preparation for conformance testing by a testing laboratory. The completed PICS proforma is referred to as a PICS.

Four conformance classes are identified in this part of ISO 10303. A conforming implementation shall support at least one conformance class. Each class specifies a subset of the AIM constructs in this part of ISO 10303. These classes are detailed in clause 6 of this part of ISO 10303.

Questions:

1. Please provide an identifier for the product or system for which conformance is claimed:

Product name and current version number: \_\_\_\_\_

2. Please indicate the implementation method chosen:

— ISO 10303-21 Exchange Structure -- preprocessor

Preprocessor name and current version number: \_\_\_\_\_

— ISO 10303-21 Exchange Structure -- postprocessor

Postprocessor name and current version number: \_\_\_\_\_

3. Please indicate the classes for which conformance is claimed:

— Class 1: \_\_\_\_\_

— Class 2: \_\_\_\_\_

— Class 3: \_\_\_\_\_

— Class 4: \_\_\_\_\_

## **Annex E**

(normative)

### **Information object registration**

#### **E.1 Document identification**

To provide for unambiguous identification of an information object in an open system, the object identifier

{ iso standard 10303 part(227) version(0) }

is assigned to this part of ISO 10303. The meaning of this value is defined in ISO/IEC 8824-1, and is described in ISO 10303-1.

#### **E.2 Schema identification**

To provide for unambiguous identification of the schema specifications given in this application protocol plant\_spatial\_configuration in an open information system, object identifiers are assigned as follows:

{ iso standard 10303 part(227) version(0) object(1) plant-spatial-configuration(1) }

is assigned to the plant\_spatial\_configuration expanded schema (see annex A).

{ iso standard 10303 part(227) version(0) object(1) plant-spatial-configuration-schema(2) }

is assigned to the plant\_spatial\_configuration short form schema (see 5.2).

The meaning of these values is defined in ISO/IEC 8824-1, and is described in ISO 10303-1.

## **Annex F** (informative)

### **Application activity model**

The application activity model (AAM) is provided as an aid to understanding the scope and information requirements defined in this application protocol. The model is presented as a set of activity figures that contain the activity diagrams and a set of definitions of the activities and their data.

#### **F.1 Application activity model definitions and abbreviations**

The following terms are used in the application activity model. Terms marked with an asterisk are outside the scope of this application protocol.

The definitions given in this annex do not supersede the definitions given in the main body of the text.

The viewpoint of the AAM is the users of plant spatial configuration information, including owner, architect, engineer, and builder.

**F.1.1 analyze final plant design (AAM A245):** examine all aspects of final design for compliance to performance criteria and generate any necessary changes required to meet these criteria.

**F.1.2 as-built documents\*:** site plans, detailed equipment descriptions, electrical instrumentation diagrams, and P&IDs that record the actual condition of a plant at a specific point in time.

**NOTE** These documents aid in meeting government documentation and safety requirements. Frequently, they are simply corrections or modifications to existing design documents delivered to construction.

**F.1.3 authorization plan\*:** high level plan, justification, and forecast for design and construction of a plant. The authorization plan describes how funds, people, and resources are to be allocated for the plant project.

**NOTE** It is a document used internally and is sometimes called a white paper.

**F.1.4 automation tools\*:** the collection of software and hardware tools used to assist the activities involved in the life cycle of a process plant.

**F.1.5 basic laws\*:** those elements of natural and human laws affecting any activity in the life cycle of a process plant.

**EXAMPLE** These laws include operating rules and guidelines as established by U.S. federal regulatory agencies such as the Occupational Safety and Health Administration (OSHA), the Environmental Protection Agency (EPA), and the Food and Drug Administration (FDA).

**F.1.6 bids\*:** commercial proposal by supplier for provision of equipment, supplies, or services.

**F.1.7 calculate heat and mass balance\* (A212):** calculations performed based on design basis, unit operations, fuel or materials in the process, along with associated chemical properties to optimize plant and operational cost.

**F.1.8 capital appropriation\*:** authorization of funding for capital project or expenditure.

**F.1.9 change request:** a request made by an user of data to revise the original or current version of something due to errors, omissions, or other reasons, such as new requirements.

NOTE 1 A request is followed by review, analysis, and approval. Change requests are tracked in terms of cost and schedule (a kind of mini-project within project).

NOTE 2 Change requests may be made against a supplier list, process, plant, procedure, and design basis.

NOTE 3 Change request originators include construction and operations.

**F.1.10 change request (design):** a request made by an user of data to revise the original or current version of the design of something due to errors, omissions, or other reasons.

**F.1.11 change request (plant):** a request made by an user of data to revise the original or current version of the design of the plant due to errors, omissions, or other reasons.

**F.1.12 change request (procedure):** a request made by an user of data to revise the original or current version of a procedure due to errors, omissions, or other reasons.

**F.1.13 change request (supplier list):** a request made by an user of data to revise the original or current version of the supplier's list due to errors, omissions, or other reasons.

**F.1.14 chemical properties\*:** chemical data needed by the process engineer during design.

NOTE - This data includes, but is not limited to:

- boiling point;
- critical pressure;
- critical temperature;
- density;
- enthalpy;
- entropy;
- flash point;
- heat of vapourization;
- melting point;

- molecular weight;
- specific heat;
- thermal conductivity;
- viscosity.

**F.1.15 codes:** widely recognized, accepted, and sometimes legally mandated rules that apply during the life-cycle of the plant. These rules govern life-cycle activities such as design, fabrication, and operation, and characteristics such as safety. Codes are consensus documents and specifications and are sometimes a subset of regulatory requirements.

EXAMPLE The ANSI 31.x series of codes.

NOTE The design basis data specified will guide the code application, i.e., how the code is applied. (ANSI 31.3 allows overpressurizing for short periods of times to accommodate specific design basis scenarios.)

**F.1.16 commission plant\* (AAM A46):** test the functionality of the completed plant prior to operation, develop final operating and maintenance procedures, and obtain final regulatory approval to operate the plant.

**F.1.17 commissioned plant\*:** a plant that has been proven to be operational through commissioning procedures.

**F.1.18 commissioning procedures\*:** step-by-step explanation of start-up actions required to commission the plant.

**F.1.19 company requirements:** those managerial decisions that place constraints on the operations of the company, that give direction or emphasis on areas for development, or that dictate decisions outside the local decision making paths. The embodiment of policies and regulations that govern the operations of a company.

**F.1.20 confirm safety and regulatory compliance (AAM A244):** establish that the final design of the plant meets specified safety and regulatory criteria.

**F.1.21 construct and commission plant\* (AAM A4):** the process of building or retrofitting a physical plant, using plans and building materials. The layout drawings and material requirements are used to establish the physical arrangement and to procure the materials required. A plan for erecting the plant is determined from material schedules, heavy equipment schedules, labor schedules, and environmental conditions (such as weather). Temporary erection material (such as scaffolding) is procured as needed. Regulatory requirements and client requirements are used to plan and erect the plant, and for the final testing and certification for operation. The result is a completed plant that meets the testing procedures defined in the project control and approval documentation.

**F.1.22 construction design specification\*:** a contractual document that gives the criteria and standards to be used in the construction of the plant.

**EXAMPLE** The specification contents include detailed construction drawings, plant layout, equipment lists, isometric models, piping and instrumentation diagrams, specifications for the construction phase of the project, and pre-commissioning, acceptance and approval, and testing procedures.

**F.1.23 construction documentation\*:** all information related to the construction of the process plant.

**EXAMPLE** Documentation includes as-built reports, equipment certification, nameplate information of installed equipment, operating manuals, testing procedures, field changes, and photographs of as-built units, modules, and plant.

**F.1.24 construction plan\*:** a description of the method(s) to be used for building or fabricating a plant or plant item.

**F.1.25 construction services\*:** constructor activities and abilities to be used to construct the plant.

**F.1.26 control and approve activities\* (AAM A11):** prepare plans, check conformance to plans, and arrange for any corrective actions.

**F.1.27 control requirements\*:** requirements and criteria specified in operating procedures and safety requirements imposed on the mechanisms and systems that monitor and control plant operation.

**F.1.28 corporate standards:** procedures, instructions, or specifications that may be used in the execution of a plant project and are standardized within an organization. Corporate standards are not project specific, but may be used (and possibly customized) by a variety of projects. Corporate standards are developed over a long period of time as standard, recommended, or best practice.

**EXAMPLE** Kinds of standards include safety, design, and maintenance.

**F.1.29 decommission and dispose of plant\* (AAM A6):** the activities during which the plant is decommissioned, disassembled, and the site either prepared for a new plant or returned to a state specified by the regulatory agencies. Records of the disposal of toxic and hazardous waste together with the location of any holes and the methodology used to plug them are produced and stored in accordance with approved procedures and guidelines.

**F.1.30 decommission plant\* (AAM A61):** plan and complete the activities required to decommission the plant.

**F.1.31 define plant operating philosophy\* (AAM A231):** ascertain and confirm those plant operating characteristics and activities necessary to achieve the plant owner's operational goals such as methods of production, technology, plant safety, or plant availability. This activity includes selecting types and sequences of unit operations and processing steps so that the plant production objectives can be achieved and specifying alternate or abnormal operating conditions, and procedures such as startup and shutdown.

**F.1.32 define procedures, standards, guidelines, specifications, and codes\* (AAM A13):** specify the engineering policies to be used and determine appropriate procedures, codes, standards, guidelines, and specifications that may apply.

**F.1.33 delivery dates\*:** scheduled date for delivery of procured items to meet or support construction.

**F.1.34 deploy component or service\* (AAM A35):** the process whereby the part or service is delivered and the acquisition agreement is fulfilled.

**F.1.35 design basis:** a document provided by the plant owner or developed by the architecture, engineering, and construction (AEC) contractors that establishes or defines the information and data that Plant engineering is to be based upon. It consists of guidelines and requirements, corporate standards, codes, references to regulatory agreements, form of deliverables, and plant or production capacity.

EXAMPLE The design basis includes:

- design safety philosophy;
- environmental requirements;
- plant inputs (e.g., fuel, feedstock);
- plant license and permit requirements;
- plant operating requirements;
- plant process requirements;
- plant product or output (type and capacity);
- site parameters (geographical, meteorological, soils, hydrological);
- type of plant.

It also addresses performance objectives for the plant such as:

- capacity;
- engineering quality;
- environmental;
- investment and project economics;
- safety and health;
- schedule;
- product and plant quality;
- product and raw material storage;
- project execution;

— technology.

**NOTE 1** Performance objectives usually take the form of a written document owned and maintained by the project team (consisting of members from the business, engineering, construction, and plant site).

**NOTE 2** The definition for design basis is from an owner's perspective.

**F.1.36 design and engineer plant (AAM A2):** the activities required to develop an appropriations request and generate a construction design specification for some modification to an existing process plant or the construction of a new process plant.

**NOTE** The appropriation request is submitted to company management for approval. Upon approval, the construction design specification is generated.

**F.1.37 design strategy\*:** a description of major steps required to complete enough design to obtain a budget estimate for business calculations as well as to begin the identification of process unknowns that may or may not require piloting. It encompasses building technology, mechanical technology, utility technology, automation technology, schedules, scope, standards and regulations, process definition, control philosophies, costs, benefits and timings, and project approach (e.g., architectural engineering, construction management, internal).

**F.1.38 disassembled plant\*:** all equipment items remaining after the disposal of a process plant.

**F.1.39 disposal documentation\*:** all information related to the disposal of the process plant including acceptance and approval procedures used in disposing all hazardous materials, residues, insulation, wiring, piping, vessels, rotating equipment, site cleanup and restoration reports, and photographs.

**F.1.40 dispose of plant\* (AAM A62):** plan and complete the activities required to dispose of the plant.

**F.1.41 energy\*:** all utilities required in the production of useful products through the operation of a process plant.

**F.1.42 engineer and design equipment (AAM A223):** preliminary sizing of all major pieces of required equipment is made at this time with enough detail to obtain budget quotes.

**EXAMPLE** This includes equipment such as refrigeration machines, purchase power substations, secondary substations, switch gear, compressors, and boilers, as well as the major process equipment specific to the plant.

**F.1.43 engineer and design plant systems (AAM A222):** at the conceptual level, this is a preliminary scoping of all major modifications or additions to major plant distribution systems such as steam, compressed air, electrical power, refrigeration, water, firewater, and sewers (storm, process, sanitary). Impact on distribution pipe lines and feeder systems quantity and size are also included. A consideration of system operation in terms of reliability, uptime, planned maintenance, and winter and summer operations are vital to proper planning.

**F.1.44 engineering design, construction, and operation changes:** changes to the design of the plant arising from errors, omissions, new requirements, or other reasons during plant design, construction, or operation.

**F.1.45 environmental impact assessment\*:** evaluation of project's or plant's affect on the environment.

NOTE A report is usually required by an environmental regulatory agency before construction can begin.

**F.1.46 equipment characteristics (functional):** describe or specify the functional requirements for the equipment: what it is supposed to do. They are items of information that describe: the service provided to the process by the equipment.

EXAMPLE For a pump, such information might include a descriptive name or title, such as 1502-B Condensate Return Pump B.

**F.1.47 equipment characteristics (performance):** describe or specify the performance requirements for the equipment: how much it is supposed to do it. They are items of information that describe the effect that equipment has on the process or other operational information.

EXAMPLE For a pump, such information might include flow rate, total developed head, and efficiency.

**F.1.48 equipment characteristics (process):** a subset of equipment functional data that describe the contribution to the process desired from equipment. Such data is specified prior to the actual selection of specific equipment to fulfill the purpose.

**F.1.49 equipment characteristics (required):** needed functional, performance, physical, or process attributes of an item that have a name and measurable value.

**F.1.50 equipment id:** an identifier assigned to a piece of equipment.

**F.1.51 equipment list:** a list of equipment in the process plant.

EXAMPLE An equipment list is comprised of, but not limited to:

- contract numbers (e.g., purchase, install);
- drawing references (e.g., P&IDs, plant arrangements);
- electrical load and type;
- identifier (e.g., tag);
- location (e.g., building, elevation, area, column row);
- name;
- service requirements (e.g., air, water, structural base, electrical power, control circuitry);

— spare requirements.

NOTE The equipment list may not include all equipment. It does not include miscellaneous equipment and devices (e.g., y-pattern strainers, inline flow meters, instruments) or valves.

**F.1.52 erect plant\* (AAM A43):** utilizing plans, materials, services and labor, build a physical plant that conforms to the detailed design.

NOTE This process begins with the site preparation; grading and primary foundations poured, and temporary roads and rails created. Utility services are provided and temporary warehouses are built.

Major equipment is moved, often in pieces, and installed on foundations with supporting steel. Site permanent buildings are built, as are pipe racks and other permanent steel. Pipe runs and pipe spools are put in place with valves and miscellaneous equipment and welded or joined. Other items such as ducting, electrical, instrumentation are installed.

**F.1.53 establish initial process control logic\* (AAM A214):** document philosophical and operational requirements between instrumentation, equipment and process.

**F.1.54 establish plant design basis\* (AAM A16):** the activity of collecting a complete and consistent set of constraints, requirements, and guidelines for subsequent engineering activities.

NOTE This activity results in the development of the design basis documents. See Design Basis.

**F.1.55 evaluate bids and negotiate purchase\* (AAM A33):** the process whereby bid packages are evaluated, a supplier is selected, and an agreement is entered into for the acquisition of the plant item(s).

**F.1.56 finalize layout, arrangement, and spatial design (AAM A242):** develop the spatial design of the plant to its final approved-for-construction state utilizing the finalized system design as the primary input.

**F.1.57 finalize system design (AAM A241):** develop the system design, expressed by flow and control information and equipment performance data, to its final state.

NOTE The resulting design serves as a basis for detailed plant design.

**F.1.58 guidelines and requirements:** specifications, instructions, and mandates specified by management that shall be followed in the plant project. These guidelines and requirements may be project specific. Guidelines are more generally applicable than requirements, which tend to be specific in terms of what must be done.

NOTE - Originators and users of guidelines and requirements are:

- architectural and engineering;
- construction management;
- constructor;
- contractor (basic practices);

- engineering and construction;
- engineering, procurement, and construction;
- owner.

These categories are not mutually exclusive.

**F.1.59 heat and mass calculations\*:** calculations performed based on design basis, unit operations, fuel or materials in the process, along with associated chemical properties to optimize plant and operational cost.

**F.1.60 identify and analyze safety requirements and hazards\* (AAM A215):** review design basis, unit operations, heat and mass balances, materials, identified equipment, control logic and process flow diagrams against federal, state and local regulations, codes and standards to determine compliance and produce an analysis of results.

**F.1.61 identify and define unit operations\* (AAM 211):** incorporate the design basis and owner requirements to define and document the basis for conceptual process design and estimated time and cost expenditures. If the design activity is related to an existing plant, then existing operations are incorporated into the conceptual process design.

**F.1.62 identify and size equipment\* (AAM A213):** identify equipment requirements based on the design basis and unit operations. Sizing of the equipment is based on the heat and mass balance calculations and unit operations.

**F.1.63 identify plant performance requirements and establish design strategy (AAM A221):** define a quantitative description of the quantity and quality of a product to be produced by the plant in a yearly time period and describe the major steps required to complete enough design to obtain a budget estimate for business calculations as well as to begin the identification of process unknowns.

NOTE Performance requirements are usually stated as units of product per unit time.

EXAMPLE Additional qualifications are typically made regarding the quality of the plant. Examples include time between major shutdowns for continuous processes, percent uptime required, and expected yield.

**F.1.64 information databases:** those elements of information collections comprising literature references, physical and transport properties, symbology sets, equipment specifications, and equipment costs that assist in the conception, design, construction, operation, and disposal of a process plant.

**F.1.65 initial information:** any knowledge available at the start of the process to build or modify a process plant.

EXAMPLE This includes information about the site, regulatory agreements, owner requirements, and approved suppliers.

**F.1.66 innovation:** new ideas and concepts generated internally or through the public domain to solve problems or to enhance the quality of work.

NOTE Some ideas and concepts may become goods, services, and systems that there is a societal requirement for. To some degree, innovation is fundamental to all activities involved with the process, however, particular emphasis is placed on activities that require generation of new ideas and concepts from abstract entities as inputs.

**F.1.67 inspection plan\*:** the description of anticipated activities necessary for surveillance of suppliers, fabricators, and assemblers to verify compliance to contractual specifications, codes, and good practice.

NOTE The plan usually lists the items to be inspected, the place where the inspections are expected to occur, anticipated frequency of inspection and type of activity to be undertaken at each inspection. The reporting procedure for the surveillance results is usually included in the developed inspection plan.

**F.1.68 inspection requirements\*:** requirements imposed by a regulatory agency related to the inspection of the plant during the decommissioning process.

**F.1.69 inspection results\*:** reports that result from inspection and supplier surveillance activities.

**F.1.70 layout plant (AAM A224):** a general arrangement of the plant in plan view, showing all the major components of the distribution systems affected by the plant and the location of the plant. A general arrangement of all major equipment within the battery limits of the plant is also included.

**F.1.71 licensed technologies:** patented or proprietary processes or design information purchased or licensed from an outside source, such as a process processor, supplier, or fabricator.

NOTE This technology may range from laboratory synthesis data through unit operation process data to complete, detailed plant designs or equipment items and modules.

**F.1.72 line schedule and list:** a subset of information presented on the P&ID, and possibly the heat and mass balance, that describes the characteristics of pipelines required for a given process.

NOTE This information is used by the piping designer during the detail design. It is analogous to the equipment list.

**F.1.73 maintain plant\* (AAM A53):** conduct and monitor the activities required to maintain the plant.

**F.1.74 maintain suppliers list\* (AAM A31):** the process whereby a list of accepted or approved suppliers is kept up to date.

**F.1.75 manage and plan project\* (AAM A1):** managing the project requires that sufficient resources be provided to execute the project and check that the execution is done in accordance with the plans and regulations. Planning the project is the activity that establishes a detailed technical plan and a financial plan that are consistent with the engineering, construction, and commissioning activities required to fulfill the project objectives.

**F.1.76 manage plant\* (AAM A51):** direct and administrate the operations, maintenance, and disposal of the plant.

**F.1.77 manage, operate, and maintain plant\* (AAM A5):** the activities required to manage, operate, and maintain the plant safely, efficiently, and according to operating procedures and regulations.

**F.1.78 management authorizations and controls\*:** management authorization, imperatives, directives, and procedures for initiating and executing plant management activities.

**F.1.79 obtain agreements with regulatory bodies\* (AAM A15):** the activity of confirming that the intended design, construction, commissioning, operation, and decommissioning of the proposed project will comply with requirements of the regulatory body. This confirmation is recorded by formal documentation such as written agreements and safety compliance reports.

**F.1.80 obtain construction services\* (AAM A42):** use the construction plan as a requirements list for outside services needed and their schedule. Negotiate contracts and agreements with sub-contractors, equipment suppliers, and labour unions as needed for the erection of the plant. Adjust the schedule of the construction plan to allow for the availability of sub-contractors, equipment and labour.

**F.1.81 operate plant\* (AAM A52):** conduct and monitor the activities required to operate the plant.

**F.1.82 operating philosophy\*:** the plant owner's operational goals.

EXAMPLE      Operational goals include methods of production, technology, plant safety, and plant availability.

**F.1.83 operating procedures\*:** documentation that covers many different phases and aspects of plant operation that is necessary to run the plant safely.

**F.1.84 optimize for environment\* (AAM A236):** evaluate the plant design against the applicable environmental regulations (Federal, State, and local) and modify the design where required.

NOTE These regulations influence many of the activities in plant and process design such as operating procedures, plant and process control strategies, specification and design of piping, instrumentation, and equipment, as well as site selection. Broad regulatory interpretations often mean that conservative measures are incorporated in plant design.

**F.1.85 owner requirements:** an initial statement of plant requirements provided by the owner.

NOTE Owner requirements are an aggregation of items such as design requirements and client general specifications. The owner requirements may be provided at any level of abstraction from very general to very specific.

**F.1.86 perform process plant life-cycle activities (AAM A0):** the completion of all tasks involved in the life cycle of a process plant from conception through final disposal.

NOTE 1 These tasks include:

- conception;
- research;
- design;
- construction;
- operation;
- maintenance;
- retrofit;
- disposal.

**NOTE 2** Major outputs from the life-cycle activities are contractual documents, regulatory compliance information, data retained beyond the life time of the plant, useful products generated by the operation of the plant, and residual materials remaining in the environment upon completion of the plant life cycle. These residual materials include waste products generated while producing the product(s) and the disassembled plant.

**F.1.87 personnel\*:** the individuals responsible for performing the life-cycle activities of the process plant.

**EXAMPLE** These individuals include discipline experts, skilled workers, and labourers.

**F.1.88 piping and instrumentation diagram (P&ID):** a schematic diagram that shows engineering details of the equipment, instruments, pipes, valves, and their connectivity and sequence.

**F.1.89 piping and instrumentation diagram (AFD):** the process definition is firm. Instrumentation needs to be added.

**F.1.90 piping and instrumentation diagram (design):** instrumentation details are included. All lines and valves have been sized. All valving, vents and drains are included. Instrumentation and loops are indicated, but final instrumentation may not have been selected.

**F.1.91 piping and instrumentation diagram (final):** the complete P&ID has been approved for release by engineering for construction and has been stamped by a registered professional engineer. It is a last version of the design P&ID. It contains all changes that were incorporated during the physical design of the systems. It reflects the plant as it was, or will be, constructed.

**F.1.92 piping and instrumentation diagram (preliminary):** conveys the flow of the fluids from equipment to equipment in the system. It shows the valves that are used to control the flow. The major fluid containing lines have been sized.

**F.1.93 plan and analyze project finances\* (AAM A14):** the activity of anticipating and estimating the financial resource requirements for a project. This activity establishes the expected financial performance for the project and the project financial plan.

**F.1.94 plant:** a portion of an installation (or the entire installation) required to operate to produce products.

EXAMPLE Products produced include chemicals, pharmaceuticals, electrical power, petroleum, and similar products.

**F.1.95 plant design documentation:** all documents related to the process of designing the process plant.

NOTE Plant design documents include the approved design methodologies, basic data describing physical properties and their correlations used in the design, kinetic data and kinetic models used in the design, corrosion data and methodology used in selecting materials of construction, supplier performance data, capital and operating cost estimates, and appropriations requests.

**F.1.96 plant items:** an item or piece of equipment that may be used as a component of the plant.

**F.1.97 plant life-cycle documentation:** the collection of all project management, design, contractual, regulatory, and disposal documents produced during the life cycle of a process plant.

NOTE This includes all data retained past the end of the plant life cycle.

**F.1.98 plant operation and maintenance documentation\*:** the collection of documents relating to the operation and maintenance of process plant.

NOTE These documents include operating records and plant data, safety and accident reports, maintenance reports, disposal records for all residual materials generated during the operation of the plant, and economic information related to product sales.

**F.1.99 plant performance requirements:** a quantitative description of the quantity and quality of a product to be produced by the plant in a yearly time period.

NOTE Performance requirements are usually stated as units of product per unit time. Additional qualifications are made regarding the quality of the Plant, such as time between major shutdowns for continuous processes, percent uptime required, and expected yield.

**F.1.100 plant records\*:** the documentation of information related to plant disposal, restoration, turnover, and regulatory approvals.

**F.1.101 pre-commission plant\* (AAM A45):** resolve any differences between the detailed design and the as-built plant, perform all testing required by regulatory agencies and the client, resolve any problems that were discovered during testing, and obtain regulatory permission to start-up the plant for functional testing.

**F.1.102 pre-commissioned plant\*:** a plant that is completed and ready for check out. Mechanical systems are complete, transfer of ownership and operation remain.

**F.1.103 prepare bid packages and solicit bids\* (AAM A32):** the process whereby the technical and commercial requirements for a plant item are compiled and sent out for pricing by multiple suppliers.

**F.1.104 process control logic\*:** prose or diagrammatic explanation of mechanisms or systems that monitor and control a process.

**F.1.105 process control logic (preliminary)\*:** initial prose or diagrammatic explanation of mechanisms or systems that monitor and control a process developed during conceptual process design.

**F.1.106 process flow diagram (PFD):** a schematic document describing the equipment units and their interconnections, major process control functions, and major stream characteristics including physical and transport properties, material flows, and energy flows.

**F.1.107 procure goods and services\* (AAM A3):** the process whereby needed plant items, equipment, or services are purchased or acquired.

**F.1.108 procured item\*:** plant item that has been obtained from a supplier for incorporation into the plant.

NOTE States or status of procured items include:

- in\_fabrication;
- accepted;
- shipped;
- delivered\_to\_site.

**F.1.109 produce as-built surveys\* (AAM A44):** the completed plant is given a physical inspection to determine whether the plant conforms to the detailed design. The detail design drawings and other documents are updated to reflect the changes to the plant discovered during the inspection.

**F.1.110 produce conceptual plant design (AAM A22):** the activity of extending the conceptual process design into a preliminary plant spatial configuration.

**F.1.111 produce conceptual process design\* (AAM A21):** the activity of defining the basic parameters of a plant flow scheme.

**F.1.112 produce conceptual safety engineering designs (AAM A225):** create designs that specifically address how the major hazards associated with the new plant are to be dealt with to ensure the safety of all personnel working in the plant as well as the general site and surrounding neighborhood population.

NOTE These hazards will have been identified during the preliminary screening reviews to identify chemical, fire and health hazards associated with the specific chemical or mechanical characteristics of the process.

**F.1.113 produce construction plans\* (AAM A41):** using site drawings, layout drawings, and other documents, determine the desired sequence for building the plant that will meet contract budget and schedule. Determine those services that will be needed from sub-contractors for the site preparation, erection, and testing of the plant. Develop detailed erection drawings and schedules for each section of the plant and for temporary structures.

**F.1.114 produce final plant design (AAM A24):** the activities required to generate a construction design specification from the process plant requirements.

NOTE The activities include designing the mechanical, electrical, and civil engineering systems of the process, designing the detailed instrumentation systems, producing piping and instrumentation diagrams and detailed equipment layout through isometric drawings or three-dimensional computer-aided design (CAD) models.

**F.1.115 produce final process design\* (AAM A23):** integration of conceptual process and plant designs to fully define parameters of a plant flow scheme.

**F.1.116 produce process flow diagrams\* (AAM A216):** production of a schematic showing basic process flow developed from the cumulative results of unit operations, equipment sizing, initial logic and safety requirements along with related chemical properties.

NOTE If a design activity is related to a modification or addition to an existing plant, then the existing plant information is reflected in the developed process flow diagram.

**F.1.117 project authorizations and controls\*:** management authorization, imperatives, directives, and procedures for initiating and executing project activities.

**F.1.118 project control and approval documentation:** a set of documents that define the standard procedures, standard software modules, or standard forms adopted to ensure that all activities in the project comply with organizational constraints. The documents indicate how all activities are to be implemented and approved and identify all constraints that must be met.

NOTE The constraints include financial limitations, accounting, legal and regulatory restrictions, socio-economic factors, and business practices throughout the plant life cycle.

**F.1.119 project financial plan\*:** document that states how much the plant will cost to construct, how it is to be paid for, and when payments are to be made. It is a general financing and cash flow document.

**F.1.120 project-specific documents:** procedures, standards, guidelines, specifications, and codes created specifically for the plant project. These documents may call out, add to, modify, or tailor a standard. Portions of these documents are derived from the design basis.

NOTE Project-specific documents evolve through stages like P&IDs and other design documentation.

**F.1.121 provide resources\* (AAM A12):** acquire and deploy personnel, tools, and funding to perform the project activities.

**F.1.122 purchase agreement\*:** contract between two parties to provide a service or item for a designated payment.

**F.1.123 qualified construction firms\*:** list of construction firms that are capable and acceptable to construct the plant.

**F.1.124 receive, inspect, and disposition components\* (AAM A34):** the process of receiving equipment and materials from various suppliers at the process plant, inspecting the equipment and

material for compliance to the purchase specification, and either placing the equipment or material in stock, delivering it to construction or maintenance, or returning it to the supplier.

**F.1.125 regulatory agreements\*:** mutual agreement between the owner or operators and regulatory agencies.

**F.1.126 regulatory authorizations\*:** approval from regulatory agencies to initiate activities.

**F.1.127 regulatory requirements:** federal, state, or local laws, codes, or standards that impact various activities related to the process plant.

NOTE Regulatory requirements may apply to, but are not limited to, permitting, engineering, construction, operations and decommissioning.

**F.1.128 request for management approval:** a document submitted to management requesting either approval to continue a particular activity of the project or requesting the procedure to use to solve a particular problem.

NOTE Approval requests may, at times, include a request that the company appropriate monies for a particular activity.

**F.1.129 residual materials\*:** all chemicals and equipment, excluding useful products, remaining in the environment at the end of the plant life cycle.

**F.1.130 resources\*:** the technology, people, and tools used to carry out the plant life-cycle activities.

**F.1.131 resources (existing)\*:** currently available technology, people, and tools used to carry out the plant life-cycle activities.

**F.1.132 safety and hazardous operations analysis\*:** the results of the evaluation of the plant design with respect to safety and hazardous operations. Identifies possible causes of faults and their consequences, and recommends remedies.

**F.1.133 safety and hazardous operations analysis (preliminary)\*:** the initial results of the evaluation of the plant design with respect to safety and hazardous operations.

**F.1.134 safety compliance reports\*:** documentation of analyses and evaluations of the plant performed with respect to safety considerations.

**F.1.135 safety system specification:** job specific document related to plant safety.

NOTE This specification may be developed from applying the design safety philosophy to plant design.

**F.1.136 satisfy safety requirements\* (AAM A235):** perform a formal plant process design, operation, and control review to assess the whether all safety requirements are met.

NOTE Plant safety requirements involve issues such as source terms for spill scenarios, vapour dispersion for combustible and toxic releases, reliability of metallurgy and other materials, component failure rates, operator response and error, fail-safe instrumentation, equipment spacing, number and size of equipment trains, radiation from fires, relief system design philosophies, deflagration test results, thermal runaways and associated vent sizing, detonations and resulting shock waves.

**F.1.137 schedules\*:** a time-based list of project tasks that describes:

- what is supposed to happen;
- when it is supposed to happen;
- task sequence and dependencies;
- restraints and constraints;
- float;
- critical path.

**F.1.138 schematic diagrams\*:** a physically non-dimensional, 2D graphical representation of the functional design of a system that does not (necessarily) encompass physical information.

EXAMPLE Types of schematic diagrams include:

- PFD;
- P&ID;
- electrical single line;
- motor control;
- control loops;
- HVAC;
- plumbing;
- input output.

NOTE Schematic diagrams evolve through stages like P&IDs and other design documentation.

**F.1.139 schematic diagrams (preliminary)\*:** an initial physically non-dimensional, 2D graphical representation of the functional design of a system that does not (necessarily) encompass physical information developed during conceptual plant design.

**F.1.140 site information (existing):** information about the physical location where the plant will be constructed and the conditions of any plant on the site (if one exists).

EXAMPLE Site information includes:

- geological data, such as before and after terrain contours, and subterranean structure, and seismic activity;

- meteorological data such as seasonal wind profile, precipitation, snowfall, and ambient temperature;
- road data;
- cadastre (property lines) zones;
- utilities.

NOTE A kind of site information included in the scope of this part of ISO 10303 is verified field dimensions. They are parameters that specify the physical and spatial characteristics of an existing item or component in a plant that have been verified by measurements taken by a second, independent agency. For example, field dimensions provided by the Plant owner for piping tie-in locations (coordinate locations and sizes) are considered as "verified" when duplicated by the AEC representative. If discrepancies are discovered during verification of the field dimensions, the initial and verification measurement processes must be repeated to assure verified dimensions.

NOTE Existing plant conditions are the characteristics of the existing plant(s) relevant to the revamp, retrofit, or expansion Plant project.

**F.1.141 societal requirements\*:** the expressed need or demand by society, on either a local, national, or global scale, for products, services, or processes.

NOTE In some instances, a market study may project the expected demand or price of a product or service required by some element of society.

**F.1.142 specifications and standards:** consensus or mandated technical descriptions of plant hardware or systems that control the design or construction of a plant.

**F.1.143 specify building and plant services (AAM A243):** establish utility and other service needs for the building(s) and plant(s) based on owner requirements, final system design, and final spatial design.

**F.1.144 specify control requirements\* (AAM A234):** define instrumentation and control system characteristics required to fulfill requirements for plant operation using the operating procedures and safety requirements.

NOTE Control systems are used to help maintain plant safety, ensure product quality, and to safeguard equipment. These systems are used to control areas such as process reactions, flows, temperatures, pressures, and levels. They operate automatically, or provide indications to plant personnel. Control requirements are generally defined in the operating procedures and specified on the P&ID and in the instrument list.

**F.1.145 specify equipment functional characteristics\* (AAM A233):** define the functional characteristics of each major item of equipment based on confirmed plant operating requirements, process technologies, and process optimization.

EXAMPLE Functional characteristics include equipment type, process stream inputs, outputs, capacities, and conditions, equipment metallurgy, piping and instrumentation, power requirements, and auxiliary systems.

**F.1.146 specify piping and instrumentation\* (AAM A232):** define piping and instrumentation required by the process plant based on the functional requirements for the plant.

**NOTE** Piping and instrumentation functional requirements are developed based on plant production capacities, process type or technology, control methodology, chemical content of process streams, and equipment layout. Also considered are alternative operating conditions, maintenance requirements, and plant operating and personal safety are issues. The results of this activity are detailed on P&IDs, line lists, equipment lists, and instrument lists.

**F.1.147 starting materials\*:** all necessary equipment components or consumable goods necessary to construct and operate the process plant for the production of useful products.

**F.1.148 status:** a report of the current state of a task, design, action, or schedule. It is a quality assurance feedback mechanism.

**F.1.149 stream data:** chemical composition, physical state, and mass quantities of process flows.

**F.1.150 supplier documentation:** drawings, manuals, calculations, etc. received from a company concerning items procured from the company, that provides information concerning design details or performance of the procured items.

**NOTE** - Statuses assigned to supplier documentation include:

- preliminary (in-process design information);
- certified (information from the supplier is warranted to correctly describe the as-delivered functional or physical data);
- released for fabrication or construction.

**F.1.151 suppliers list\*:** a list of companies that provide commodities or services to an organization.

**NOTE** - Kinds or statuses of supplier lists include:

- approved;
- recommended;
- partnered.

**F.1.152 system design (preliminary):** at the conceptual level, this is an initial definition and representation of the physical components or items of the system.

**F.1.153 system layout (preliminary):** at the conceptual level, this is an initial definition and representation of the spatial configuration or arrangement of the system, showing all the major components of the system.

**F.1.154 system layout and design:** the definition and representation of the physical components or items and spatial configuration of the system in sufficient detail to support construction.

NOTE 1 This definition results from the use of the system design basis, P&IDs, specifications, and other documentation or information.

NOTE 2 The definition of the term "system" is broader than common usage, e.g., it encompasses structural systems.

NOTE 3 System layout and designs can be viewed or categorized according to the following breakdowns:

— evolutionary phase

- a) Initial;
- b) Design;
- c) Final.

— system type

- a) Piping;
- b) HVAC;
- c) Electrical;
- d) Instrumentation and Control;
- e) Structural and Civil;
- f) Architecture;
- g) Safety.

— functional views

- a) Conceptual arrangement;
- b) Spatial information;
- c) Schematic diagram;
- d) Piping and instrumentation diagram (includes piping connectivity and sequencing).

EXAMPLE The final HVAC spatial information system design and layout will specify the definition, physical dimensions, location coordinates, and characteristics for all HVAC components that occupy space in the Plant. Only those physical dimensions, location coordinates, and characteristics required to specify the spatial instance of each component are included in this definition.

**F.1.155 system layout and design (preliminary):** the initial definition and representation of the physical components or items and spatial configuration of the system.

**F.1.156 time and cost estimate\*:** projected or forecasted cost and length of time to design, produce, or procure a plant item, obtain a service, or achieve some goal.

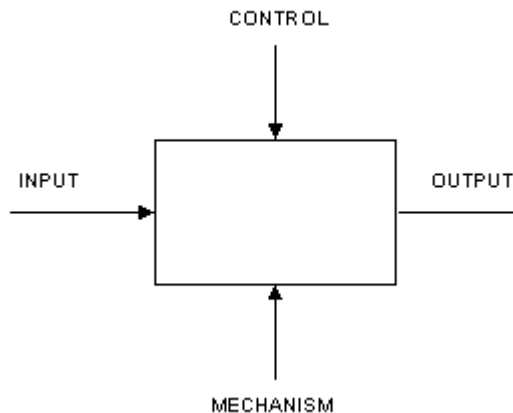
**F.1.157 unit operations\*:** design basis and owner requirements that define the basis for conceptual process design.

**F.1.158 useful products\*:** the materials or energy generated through the operation of the process plant that are sold to customers for a profit.

## F.2 Application activity model diagrams

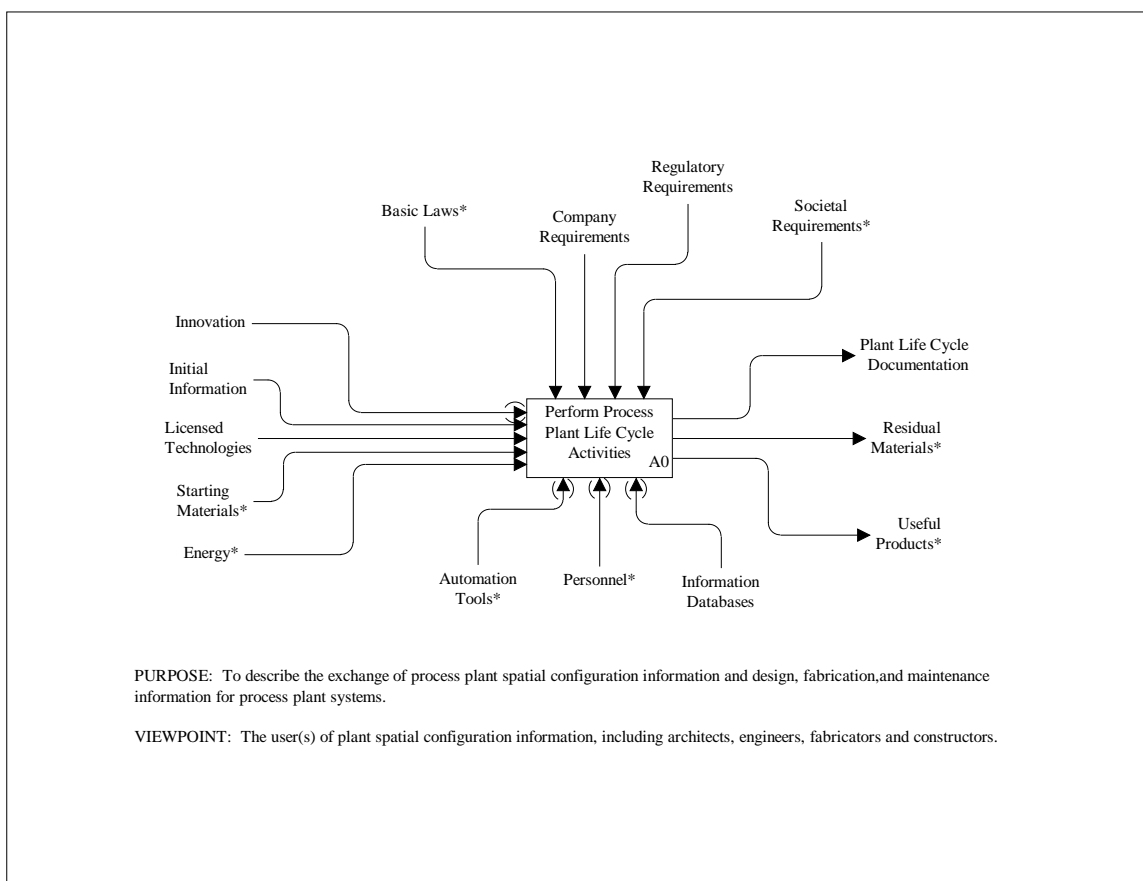
The application activity model diagrams are given in figures F.2 through F.23. The graphical form of the application activity model is presented in the IDEF0 activity modelling format. Activities and data flows that are out of scope are marked with asterisks.

Figure F.1 describes the basic notation used in IDEF0 modelling. Each activity may be decomposed to provide more detail. If an activity has been decomposed, a separate diagram is included.



**Figure F.1 - IDEF0 basic notation**

As with any IDEF0 model, the AAM is dependent on a particular viewpoint and purpose. The purpose of the AAM is to describe the exchange of process plant spatial configuration information and design, fabrication, and maintenance information for process plant piping systems.



**Figure F.2 - A-0: Process Plants**

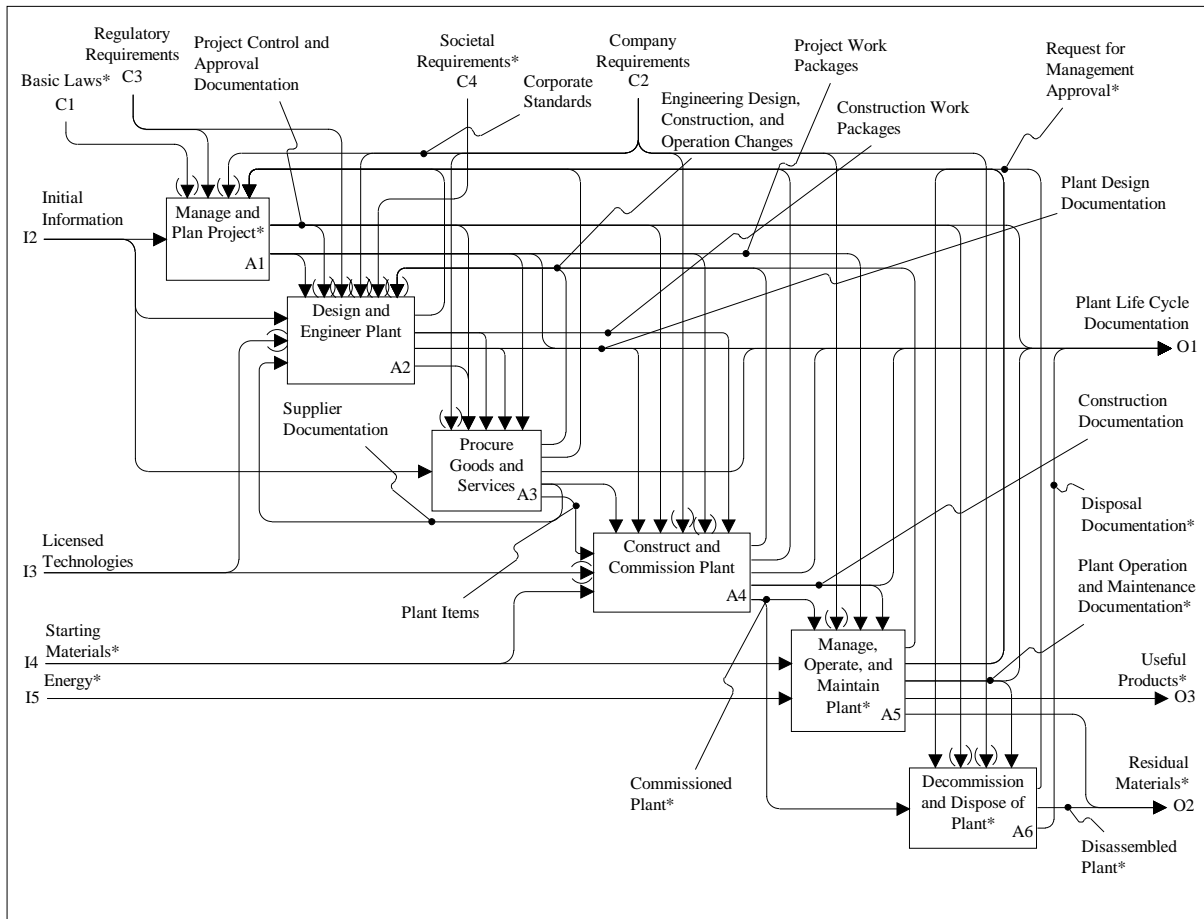


Figure F.3 - A0: Perform Process Plant Life-cycle Activities

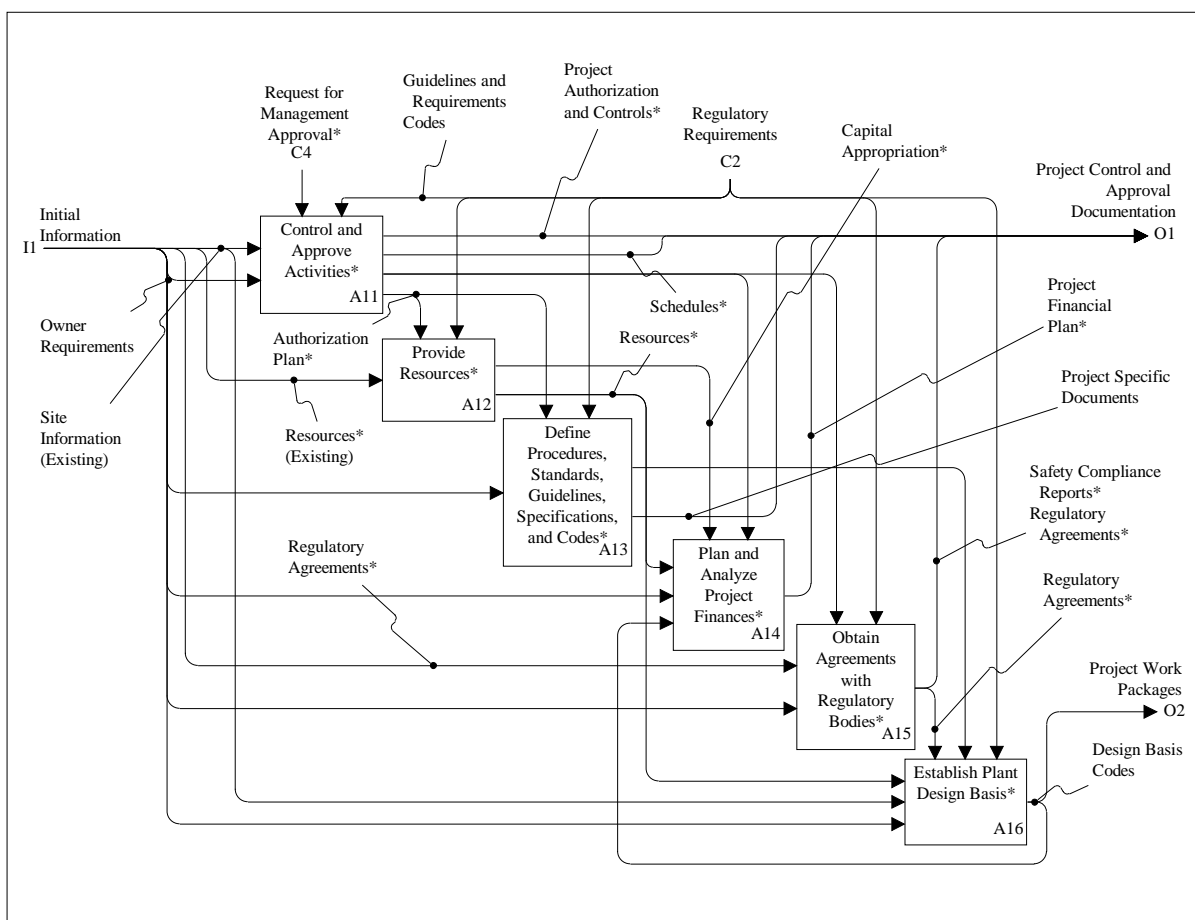
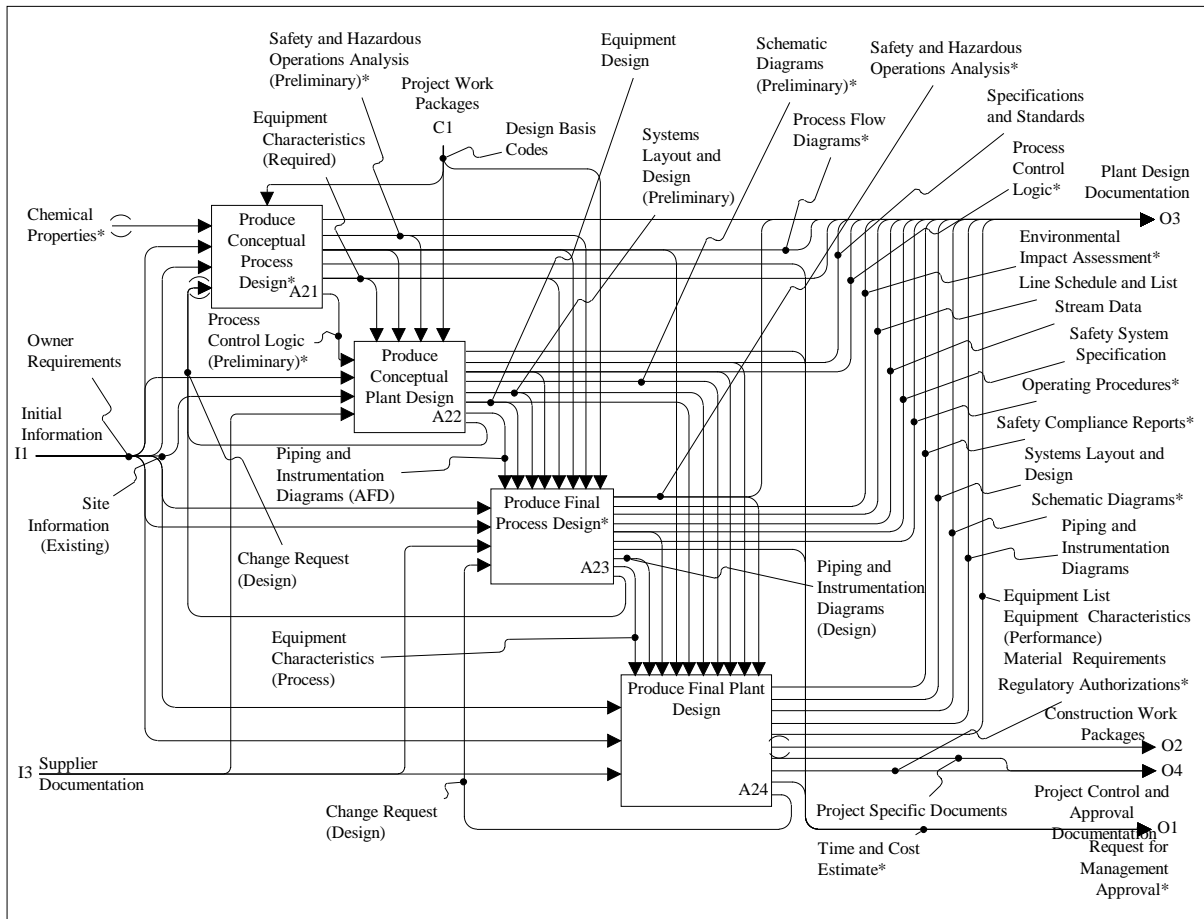


Figure F.4 - A1: Manage and Plan Project



### Figure F.5 - A2: Design and Engineer Plant

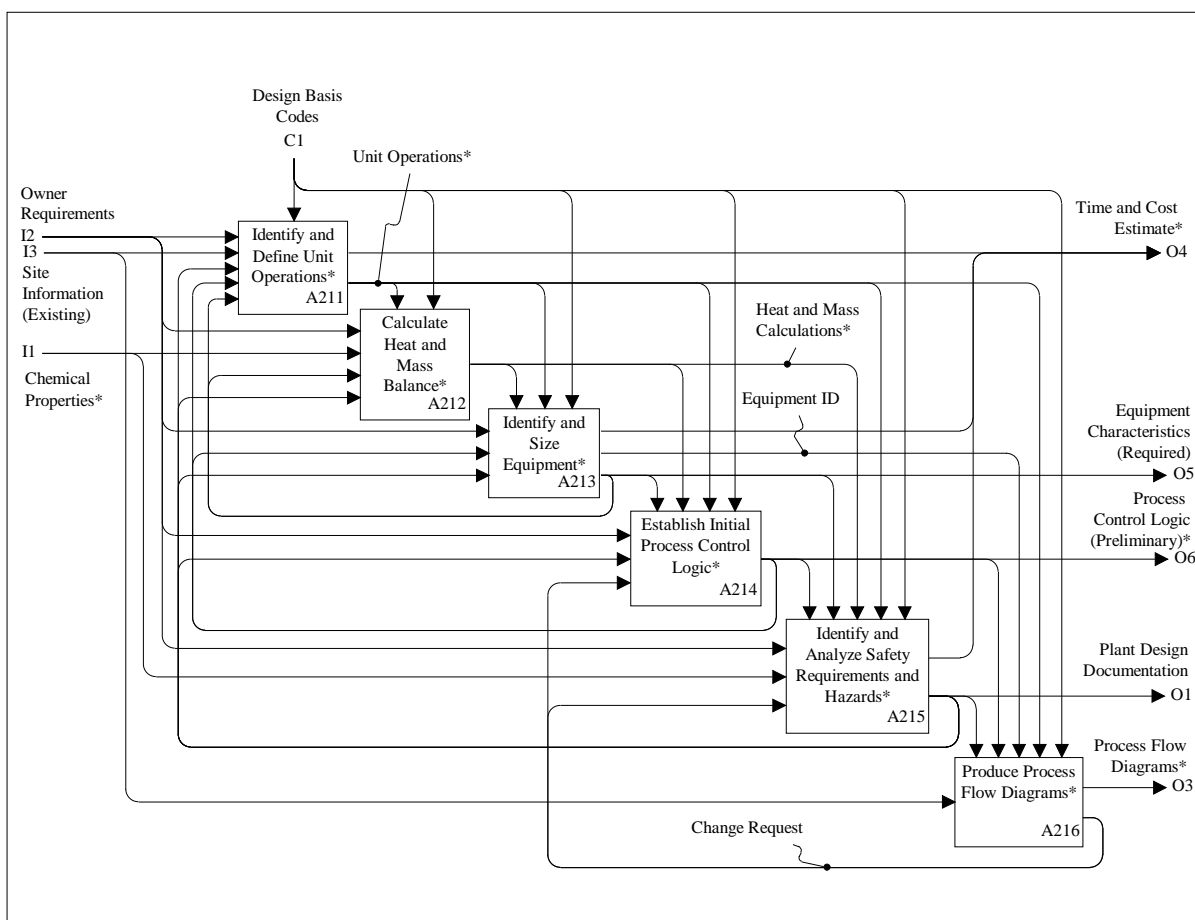


Figure F.6 - A21: Produce Conceptual Process Design

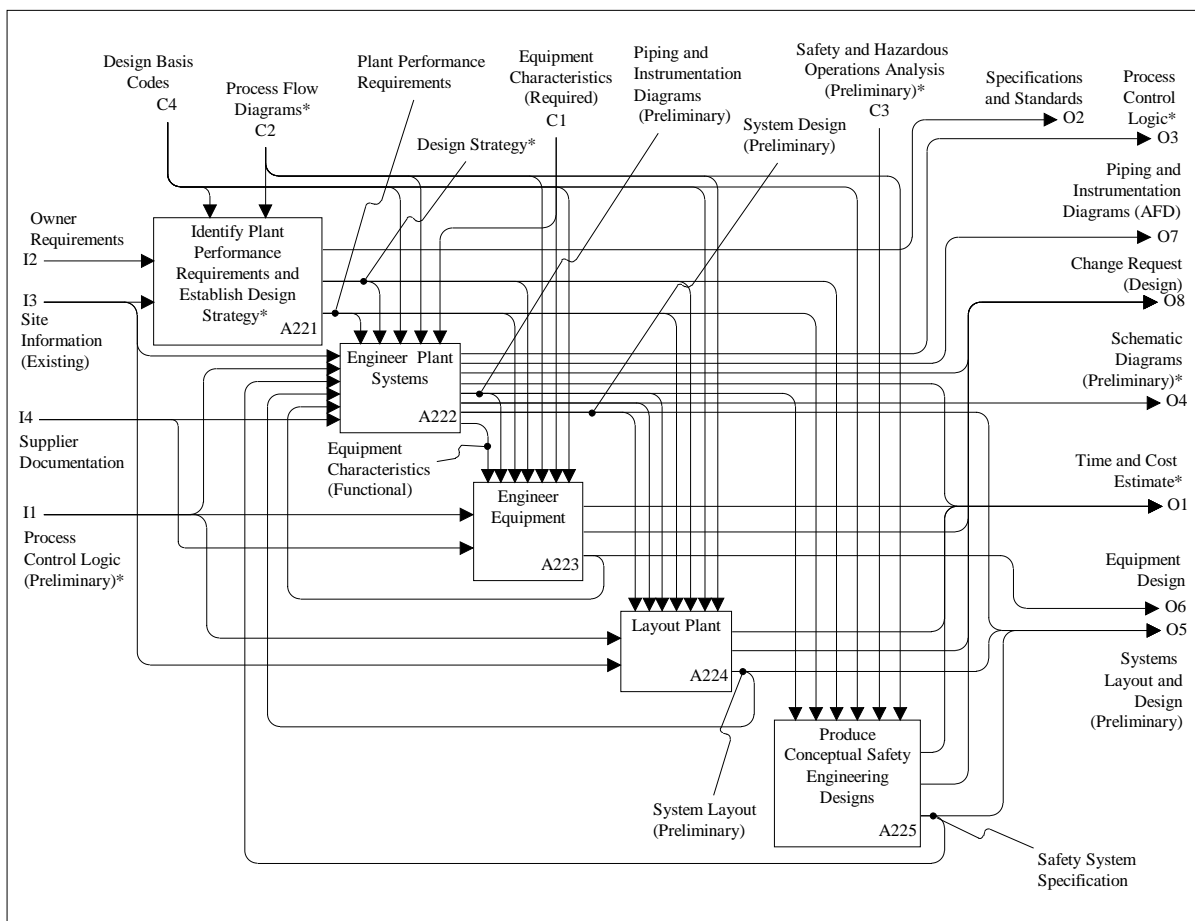


Figure F.7 - A22: Produce Conceptual Plant Design

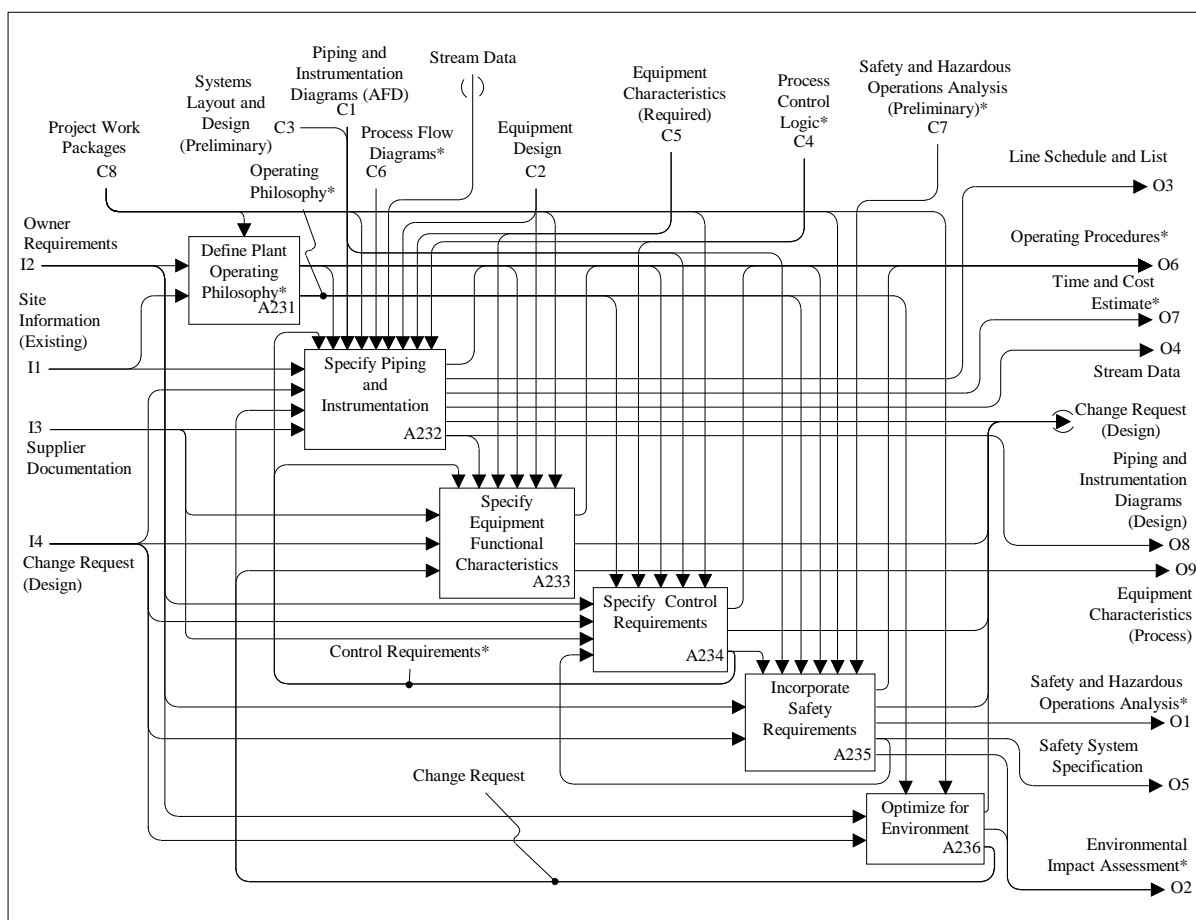


Figure F.8 - A23: Produce Final Process Design

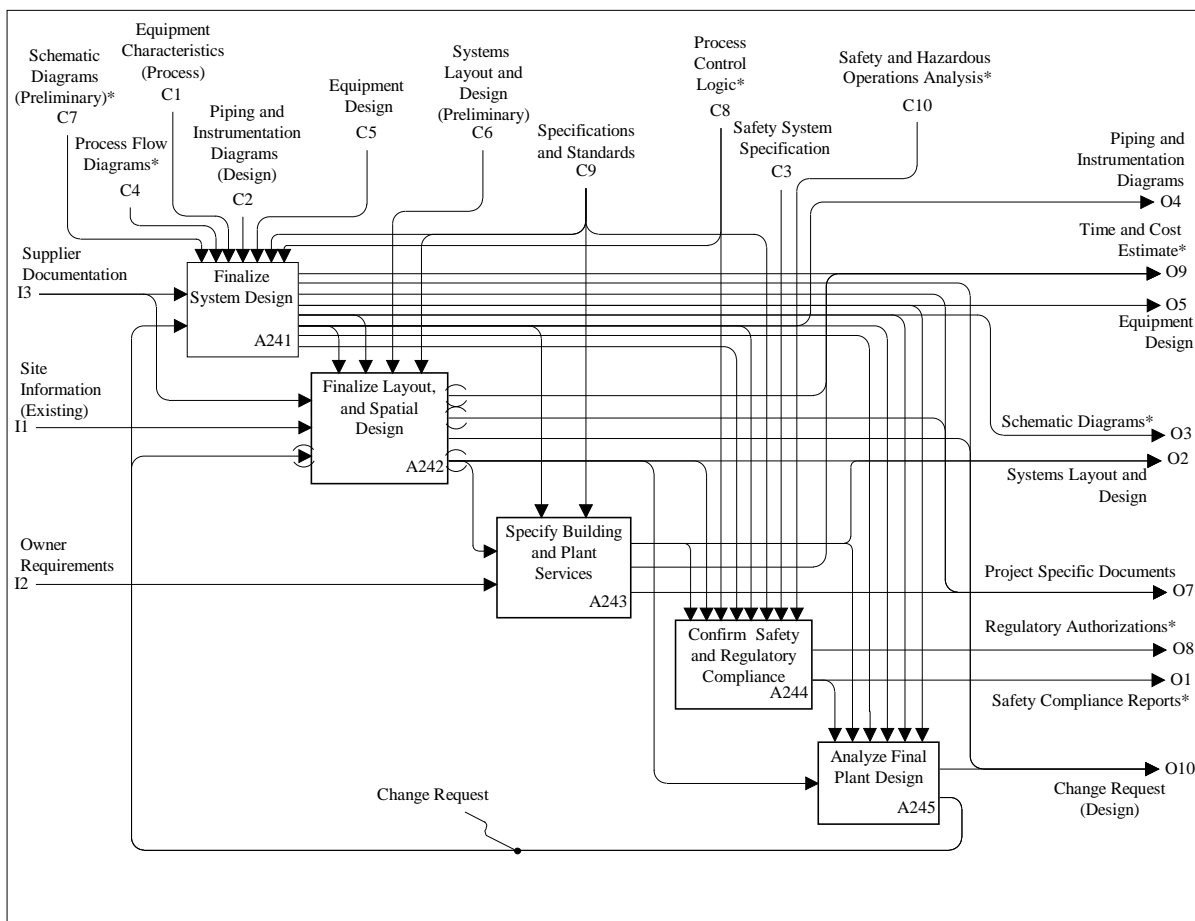


Figure F.9 - A24: Produce Final Plant Design

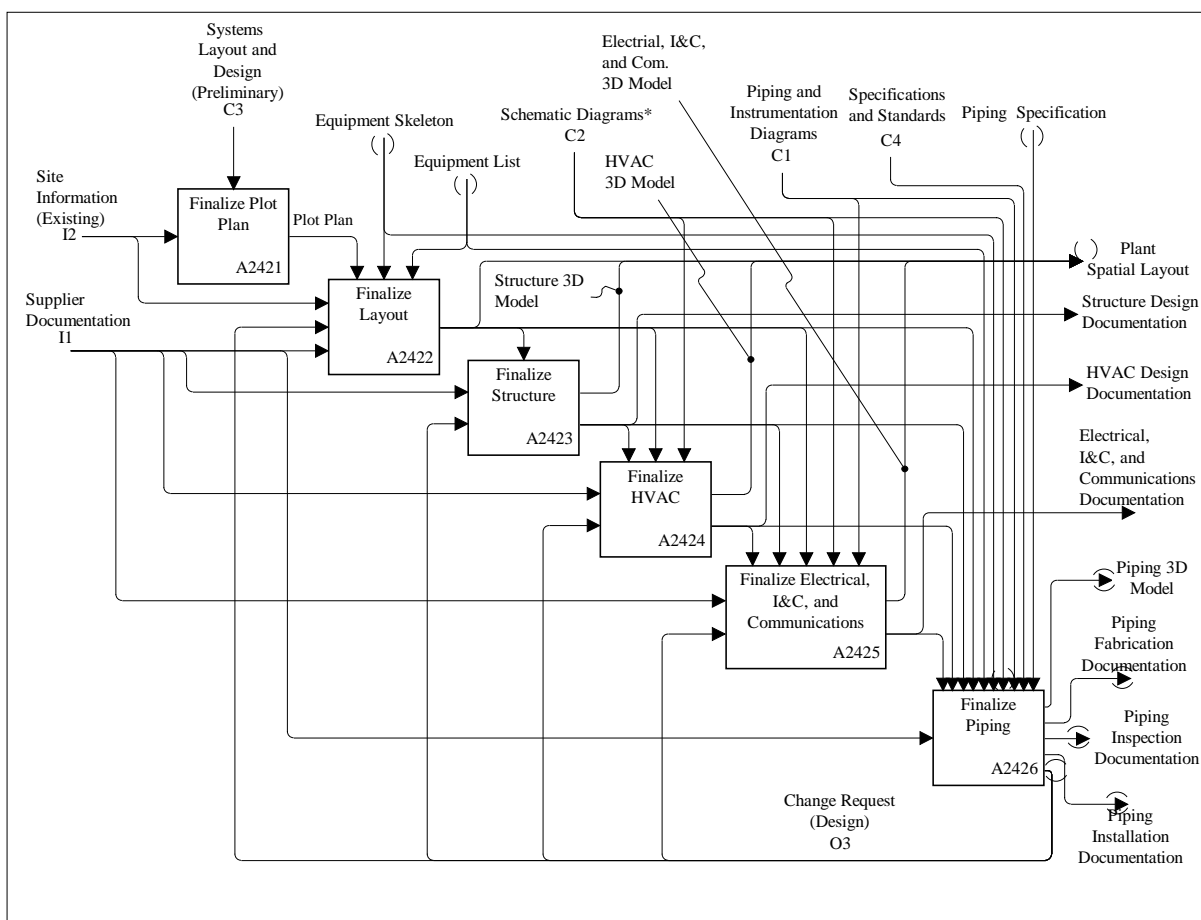


Figure F.10 - A242: Finalize Layout and Spatial Design

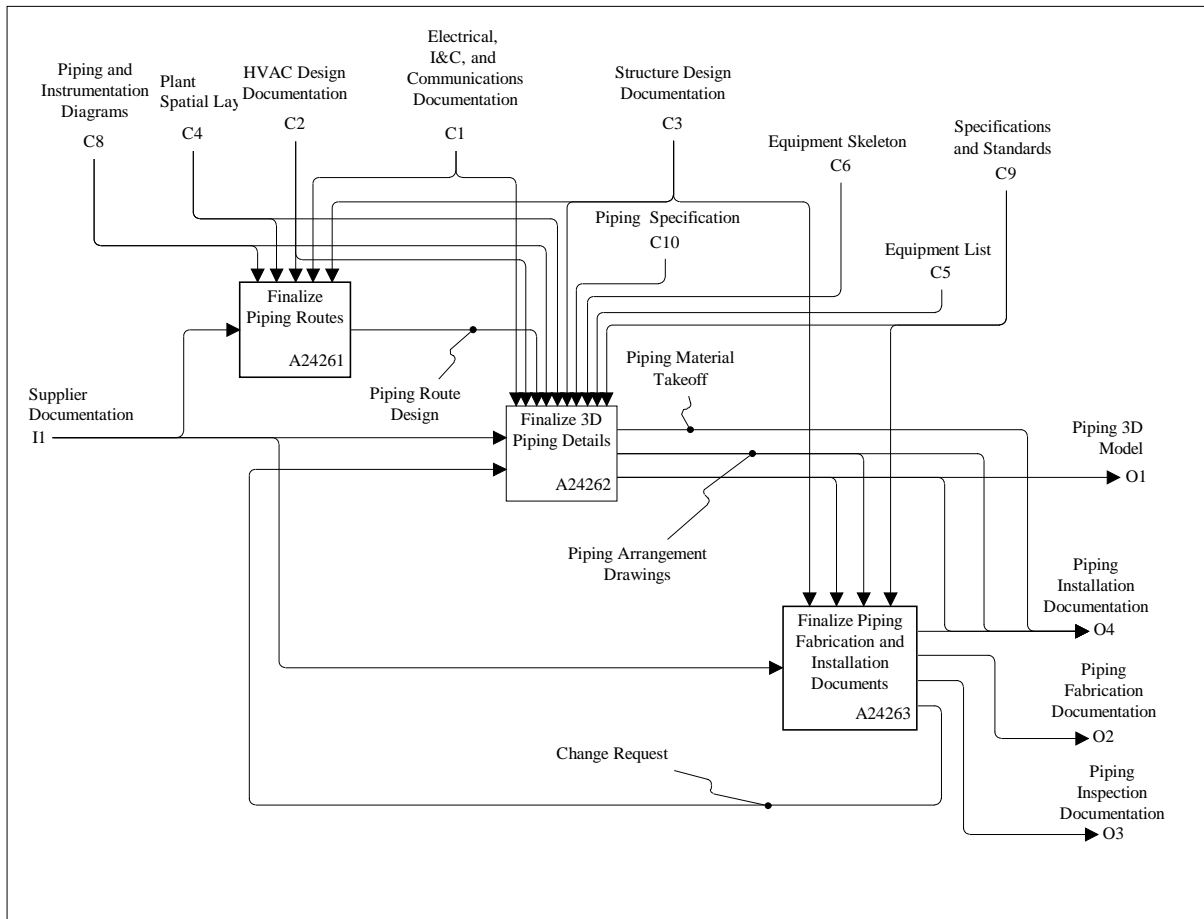


Figure F.11 - A2426: Finalize Piping

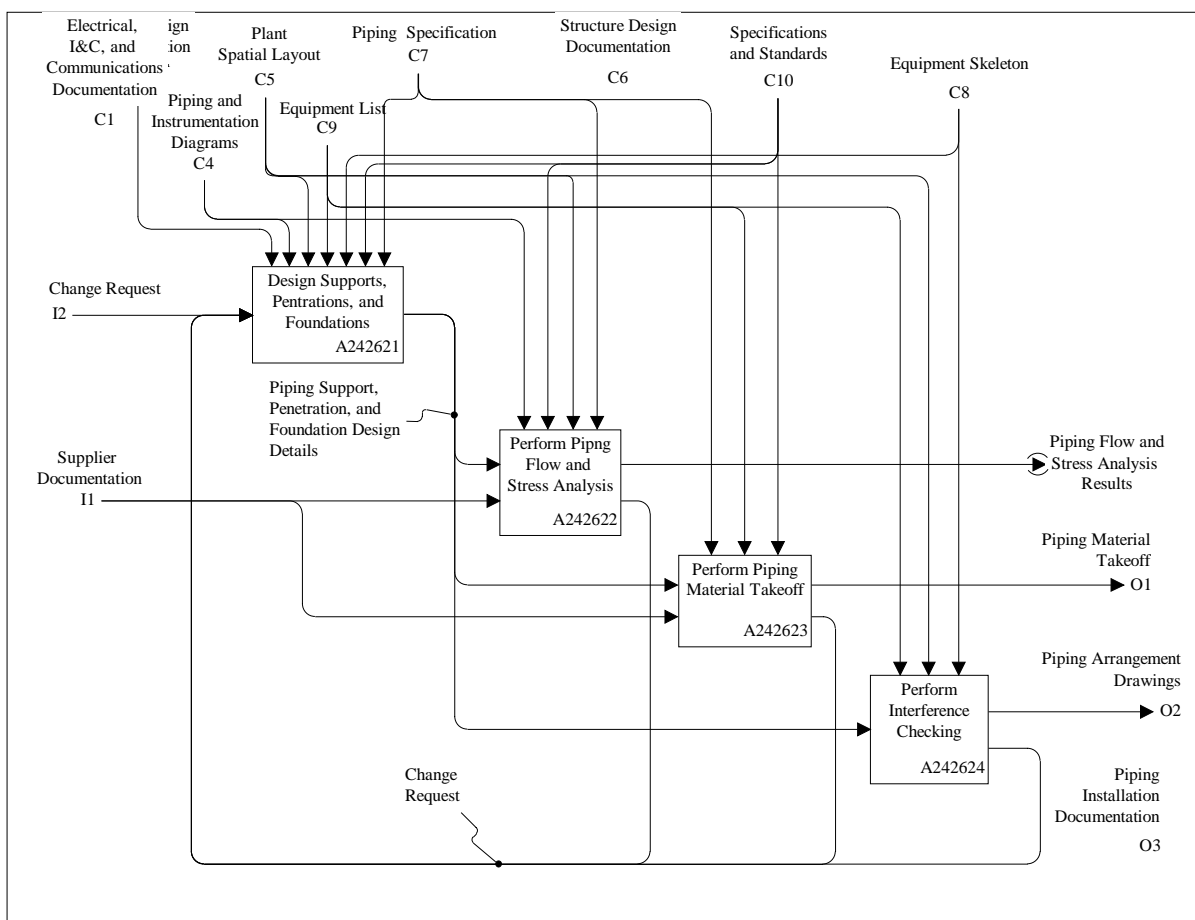


Figure F.12 - A24262: Finalize 3D Piping Details

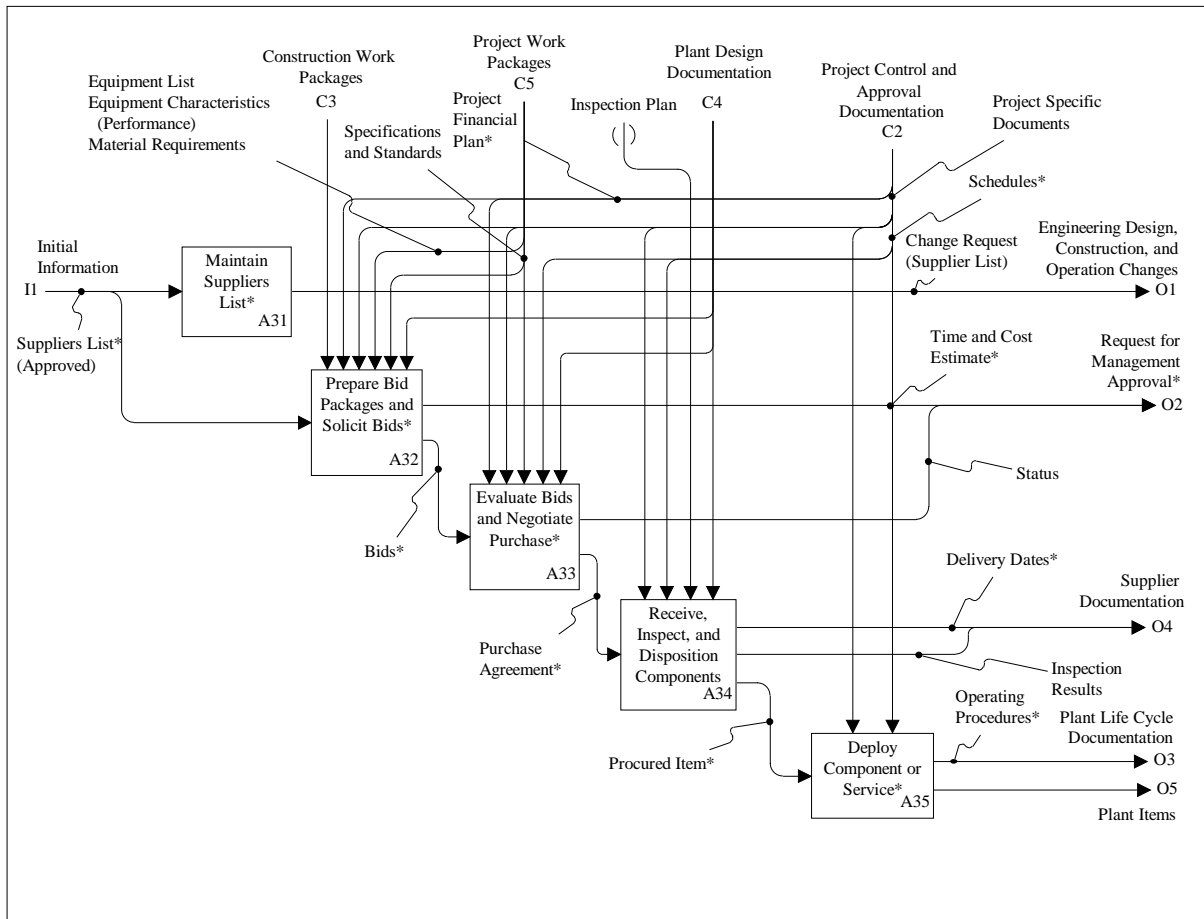


Figure F.13 - A3: Procure Goods and Services

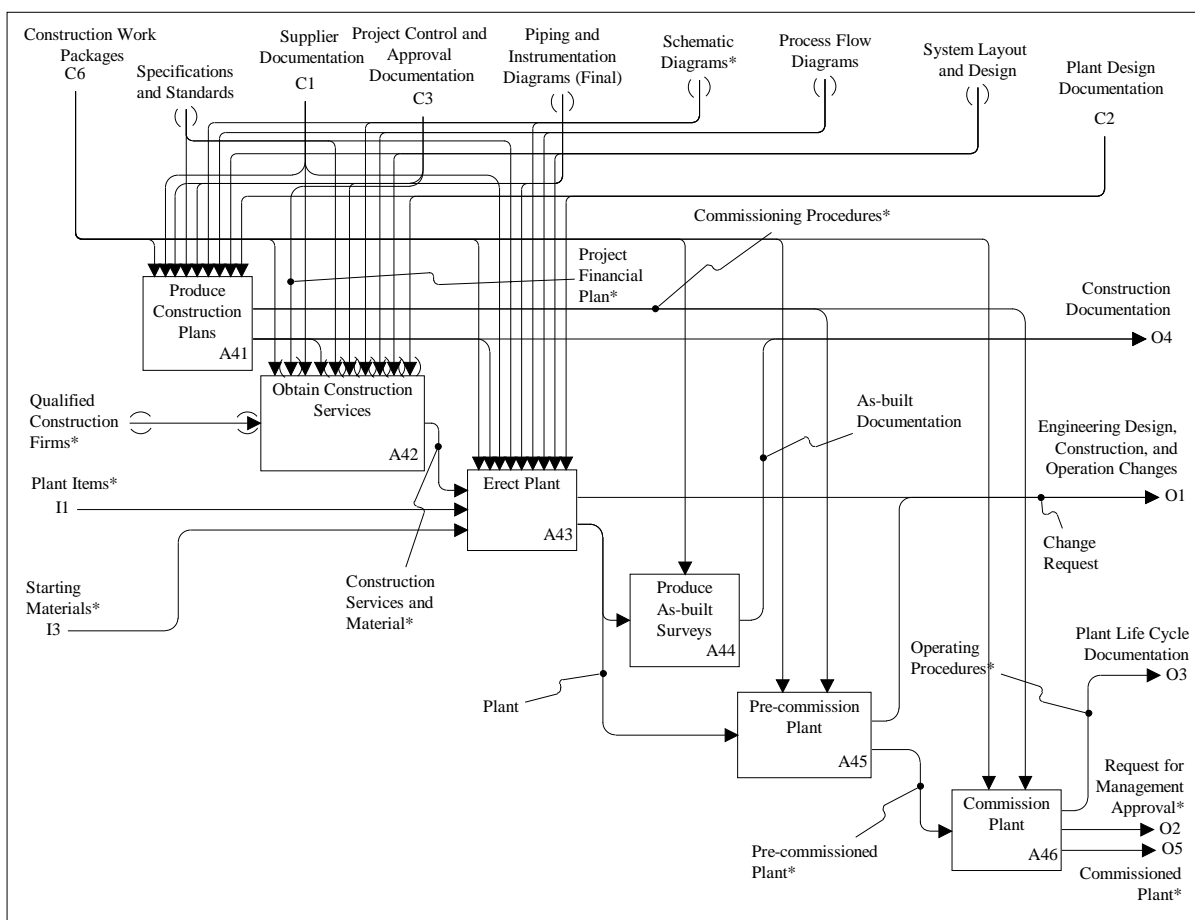


Figure F.14 - A4: Construct and Commission Plant

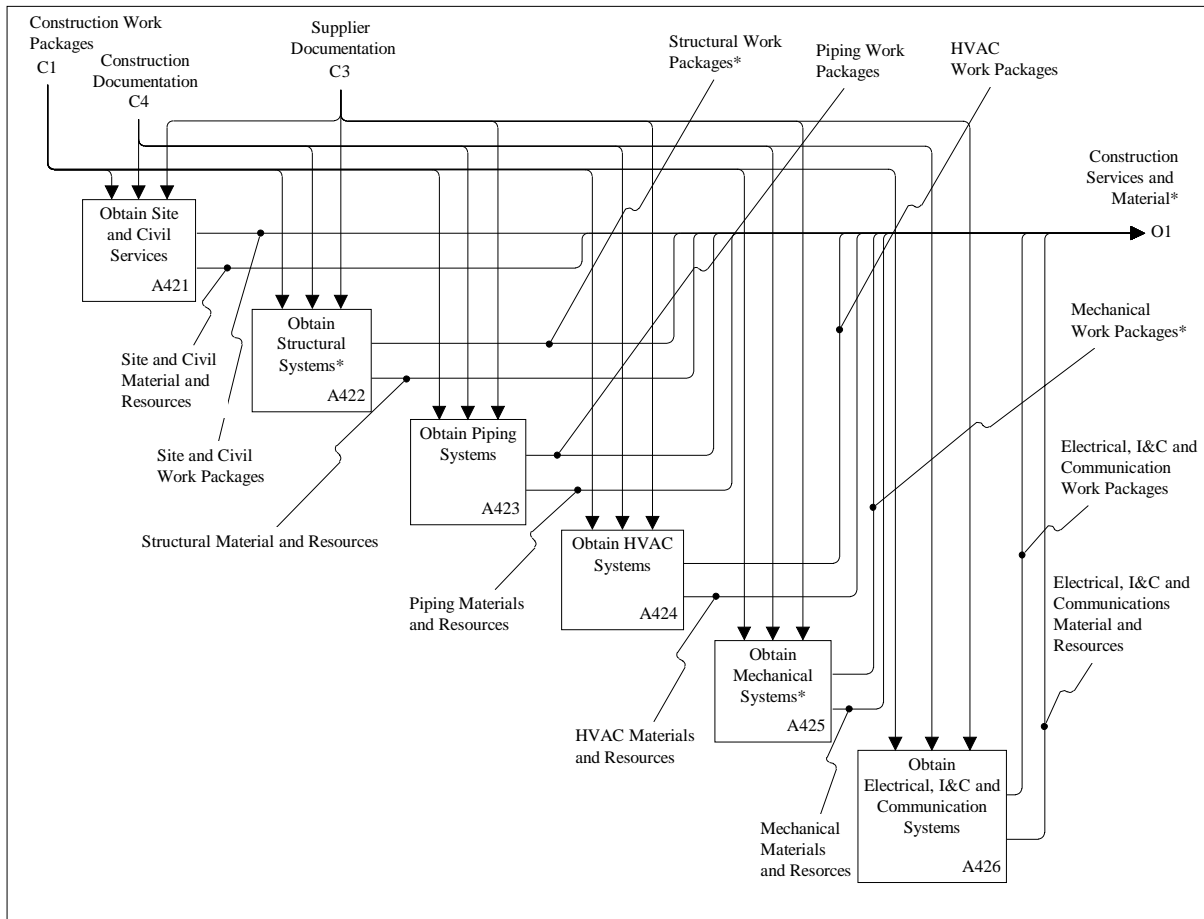


Figure F.15 - A42: Obtain Construction Services

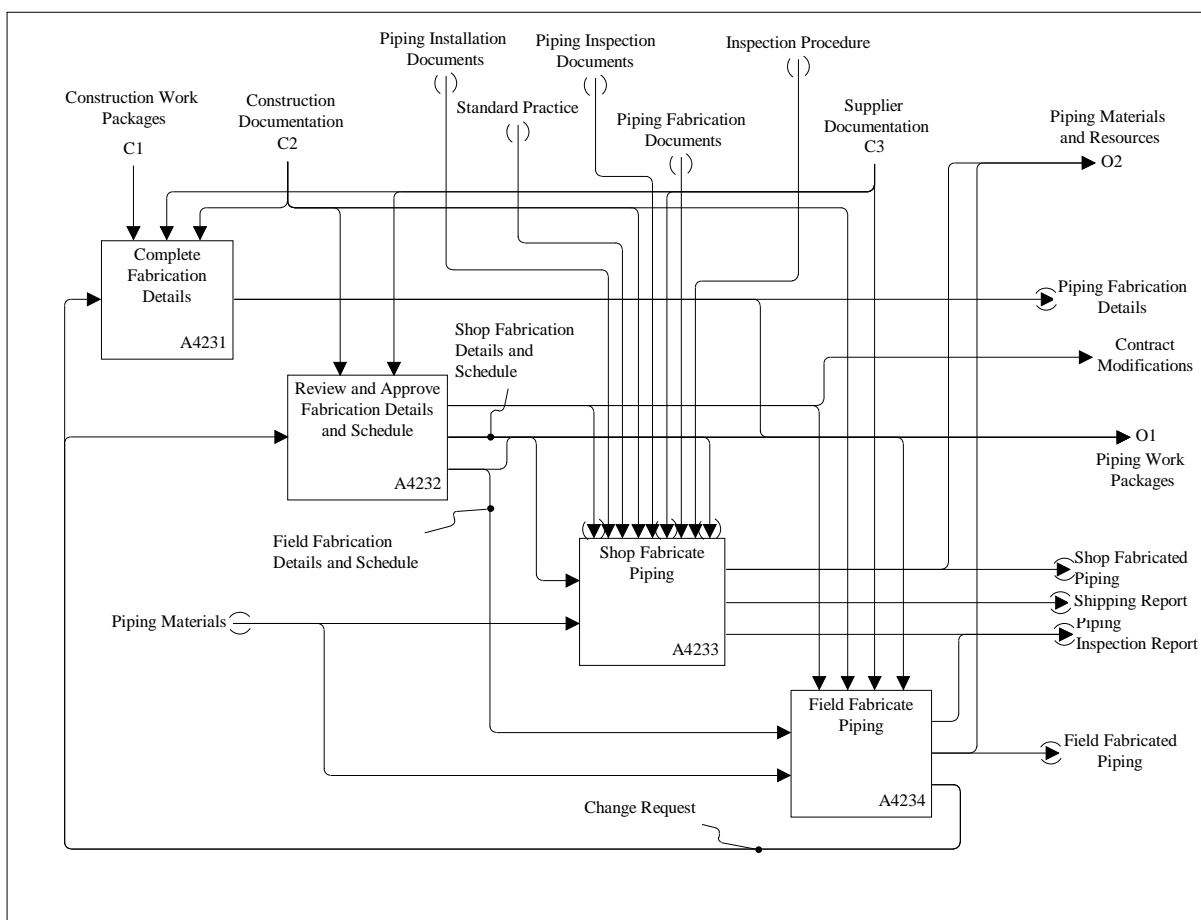
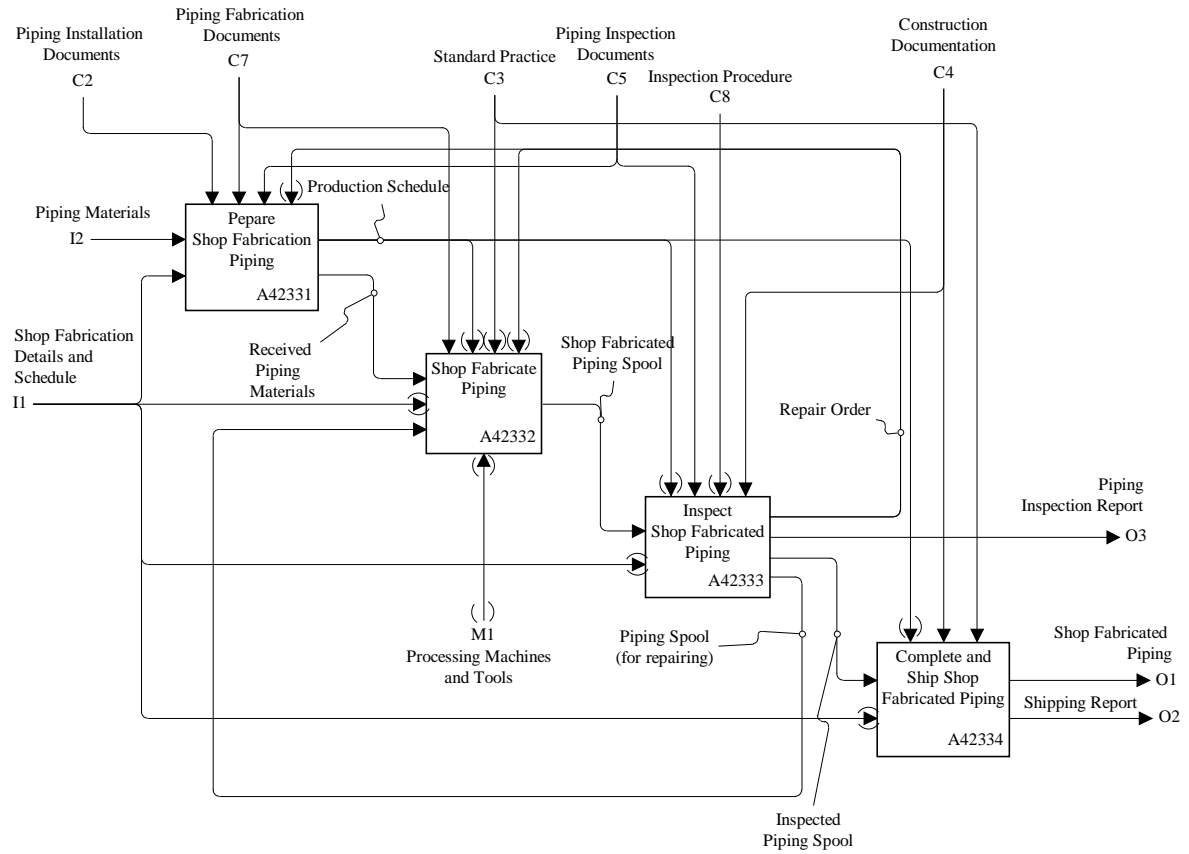
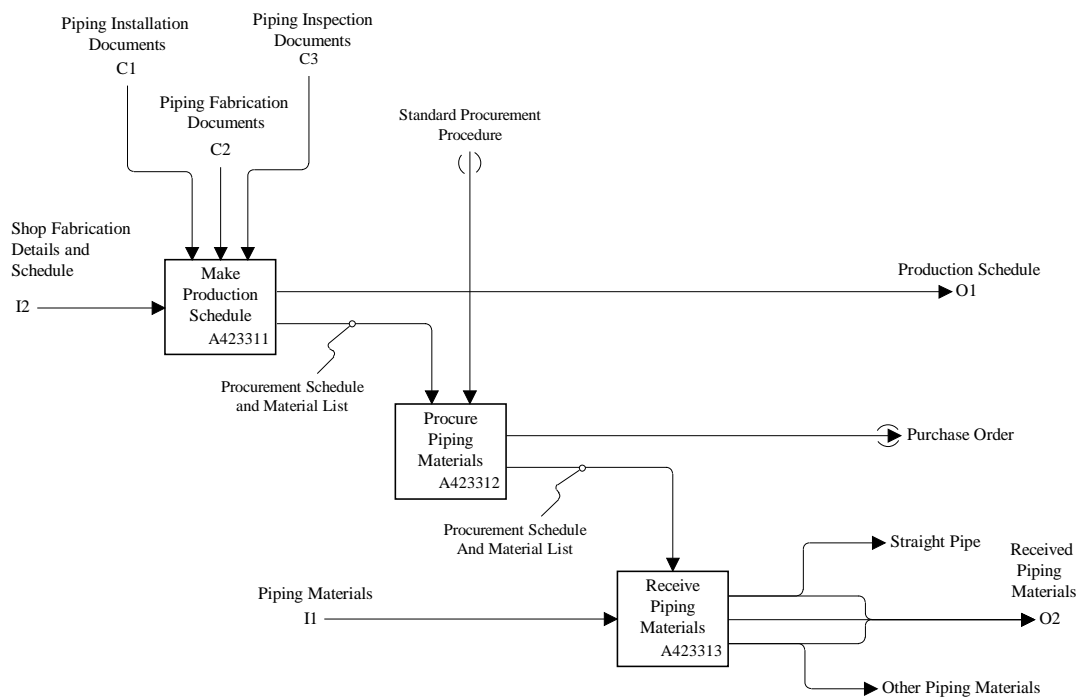


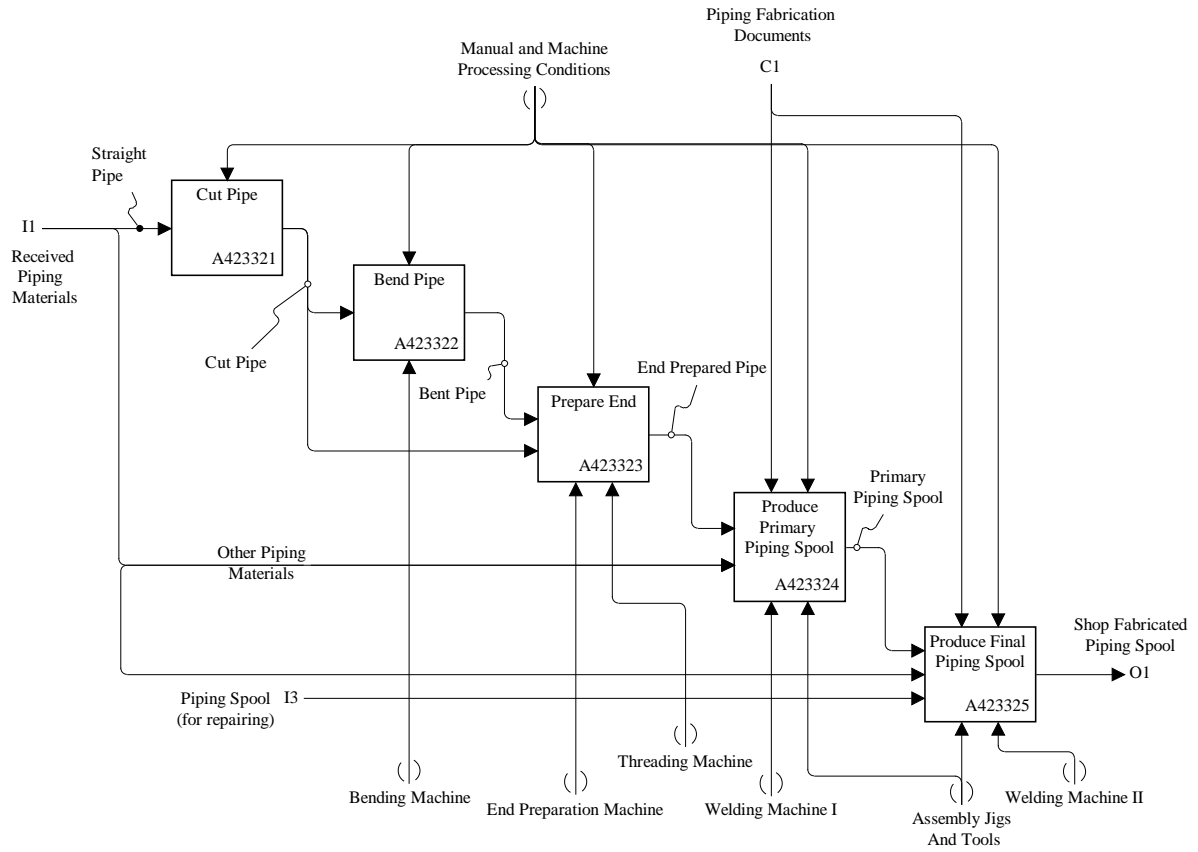
Figure F.16 - A423: Obtain Piping Systems



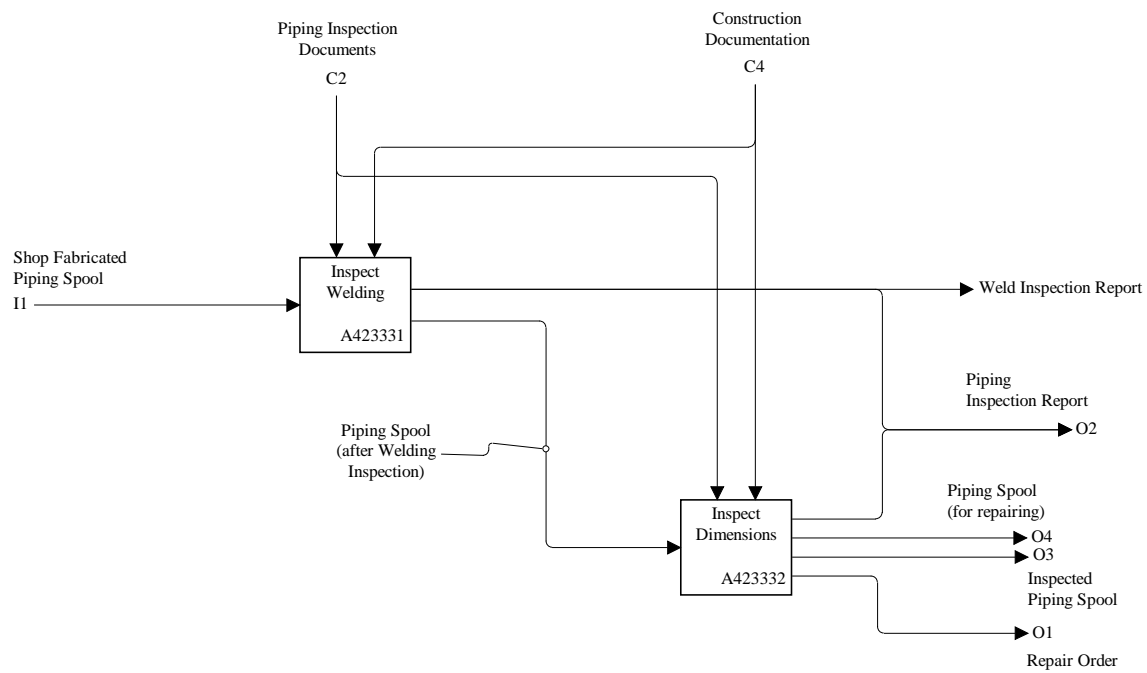
**Figure F.17 - A4233: Shop Fabricate Piping**



**Figure F.18 - A42331: Prepare Shop Fabrication Piping**



**Figure F.19 - A42332: Shop Fabricate Piping**



**Figure F.20 - A42333: Inspect Shop Fabricated Piping**

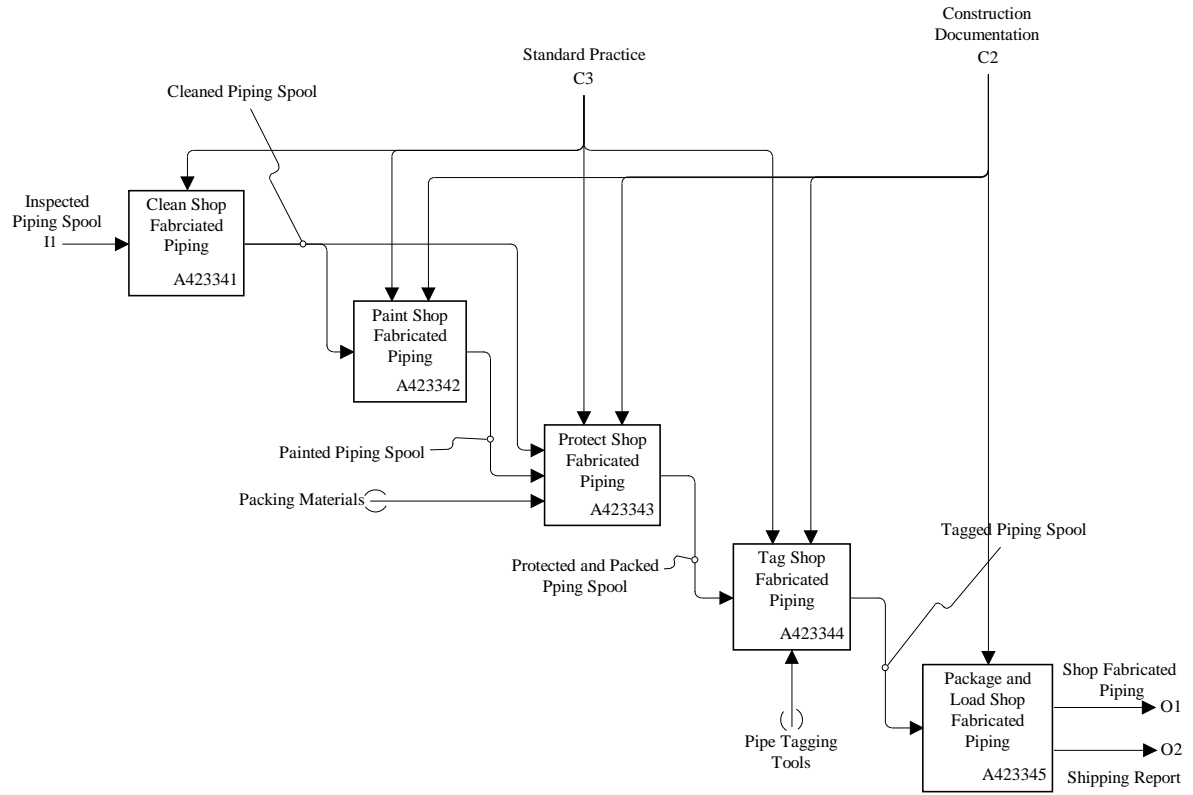
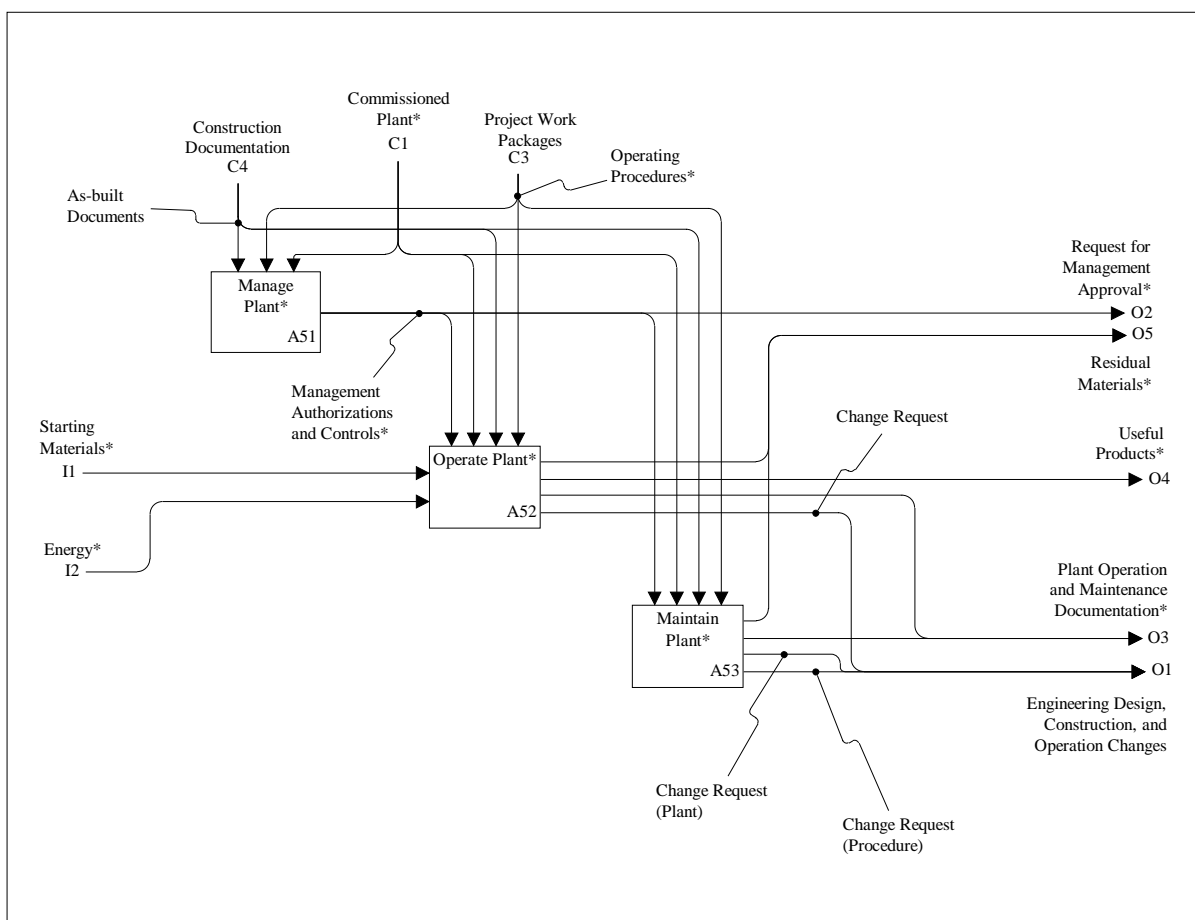


Figure F.21 - A42334: Complete and Ship Shop Fabricated Piping



**Figure F.22 - A5: Manage, Operate, and Maintain Plant**

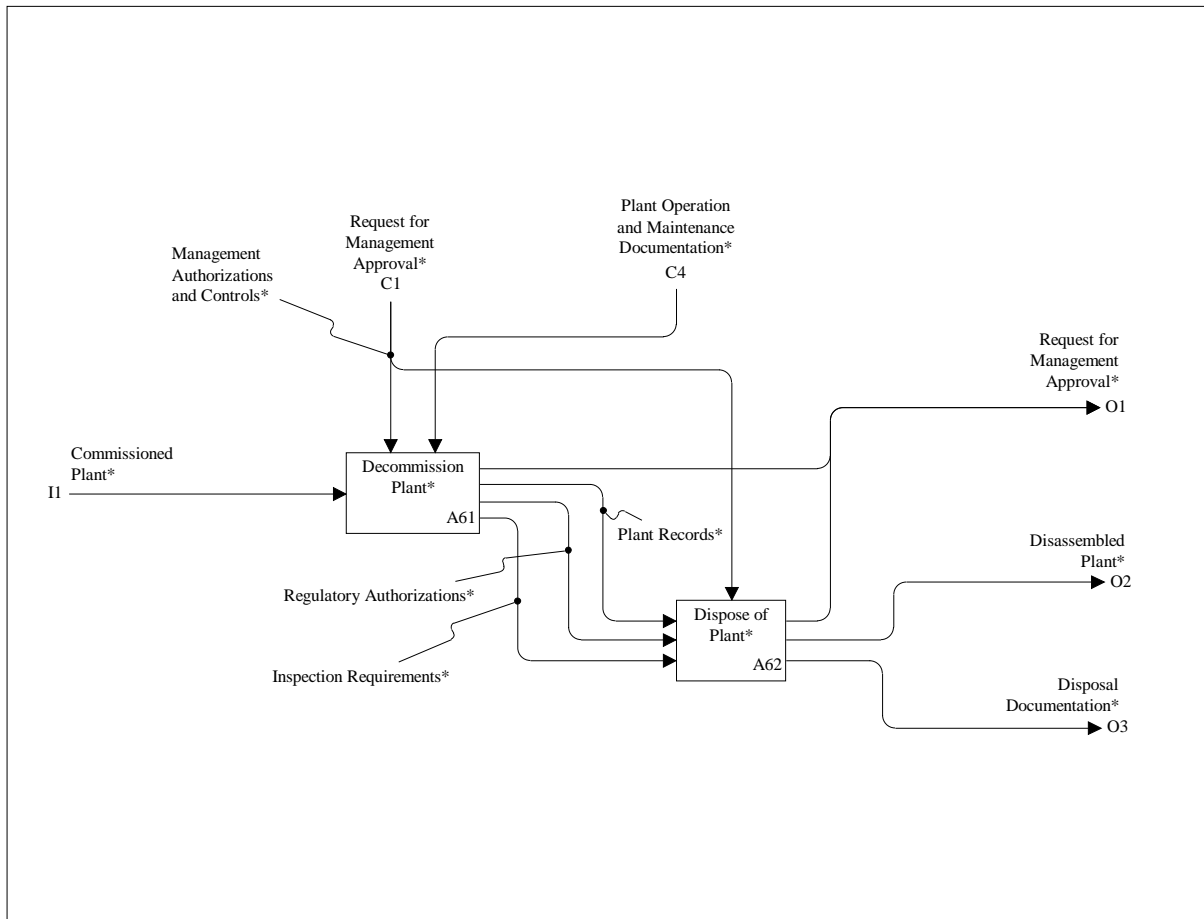


Figure F.23 - A6: Decommission and Dispose of Plant

### **F.3 AAM/ARM Correspondence**

An analysis of the correspondence between the in-scope data flows of the AAM and the ARM has been completed. This analysis mapped the in-scope inputs, controls, outputs, or mechanisms (ICOMs) identified in this annex to the ARM UoFs and entities identified in 4.1 and 4.2, respectively. The AAM ICOMs and their corresponding ARM UoFs and entities are shown in Table F.1. The results of this analysis indicated that all of the in-scope ICOMs were covered by one or more ARM entities.

**Table F.1 - AAM ICOM to ARM UoF/entity mapping**

AAM ICOM	ARM UoF	ARM Entity
Change Request Change Request (Design) Change Request (Plant) Change Request (Procedure) Change Request (Supplier List)	Change_information	All entities in the UoF
Equipment Characteristics (Functional) Equipment Characteristics (Performance) Equipment Characteristics (Process) Equipment Characteristics (Required) Equipment List Equipment ID	Equipment_characterization	All entities in the UoF
	Piping_component_- characterization	All entities in the UoF
Codes Corporate Standards Design Basis Guidelines and Requirements Owner Requirements Project-specific Documents Regulatory Requirements Safety System Specification Specifications and Standards	Connector	Piping_connector Piping_connector_- service_characteristic
	Equipment_characterization	Equipment
	Piping_component_- characterization	Piping_size_description Pressure_class Schedule
	Piping_system_functional_- characterization	Piping_specification Piping_system Piping_system_line Stream_design_case

**Table F.1 - AAM ICOM to ARM UoF/entity mapping - (continued)**

<b>AAM ICOM</b>	<b>ARM UoF</b>	<b>ARM Entity</b>
	Plant_characterization	Piping_system
	Plant_item_characterization	Construction_material Design_project Functional_design_view Material_specification_- selection Physical_design_view Piping_system_- component Required_material_- description Specification_item_- family Structural_component
Line Schedule and List	Piping_system_functional_- characterization	Line_piping_system_- component_assignment Piping_system_line
Material Requirements	Plant_item_characterization	Material_specification_- selection Material_specification_- subset_reference
Plant	Plant_characterization	Plant
Plant Items	Plant_item_characterization	Plant_item
Plant Performance Requirements	Plant_characterization	Functional_plant Plant Plant_process_capability
Site Information (Existing)	Site_characterization	Site
Status	Change_information Shape	Change Plant_item_- interference_status
Stream Data	Piping_system_functional_- characterization	Stream_design_case Stream_phase
System Design (Preliminary) System Layout System Layout and Design System Layout and Design (Preliminary)	Piping_system_functional_- characterization	All entities in the UoF
	Plant_characterization	All entities in the UoF
	Plant_item_characterization	All entities in the UoF

**Table F.1 - AAM ICOM to ARM UoF/entity mapping - (continued)**

AAM ICOM	ARM UoF	ARM Entity
	Site_characterization	All entities in the UoF
Supplier Data	Equipment_characterization Plant_item_characterization	Equipment Catalogue_definition Catalogue_item

The analysis also indicated that the scope of the AP described by the ARM is more refined than that of the AAM in that not all of the entities defined in the ARM map back to an AAM ICOM. A listing of the ARM entities is provided in table 4 of the *Application Protocol 227 Validation Report Version 1.1* [11]. This listing shows whether an ARM entity is related to an AAM ICOM, and if not, what UoF it is part of. The results of this review show that the all the ARM entities that are not mapped from an AAM ICOM are related to connections between items (connection and connector UoFs), item representation (shape\_representation and wireframe\_geometry UoFs), or item shape (shape UoF).

## Annex G

(informative)

### Application reference model

This annex provides the application reference model for this part of ISO 10303 and is given in figures G.2 through G.43. The application reference model is a graphical representation of the structure and constraints of the application objects specified in clause 4. The graphical form of the application reference model is presented in IDEF1X. The application reference model is independent from any implementation method. The diagrams use the IDEF1X graphical notation [2].

Extensions to the IDEF1X notation are used within the ARM diagrams through the use of symbols to denote off-page connectors. The symbols for the off-page connectors and their usage are drawn from the EXPRESS-G graphical modeling language and have the same meaning. Figure G.1 illustrates how off-page connectors are used to link relationships on different pages.

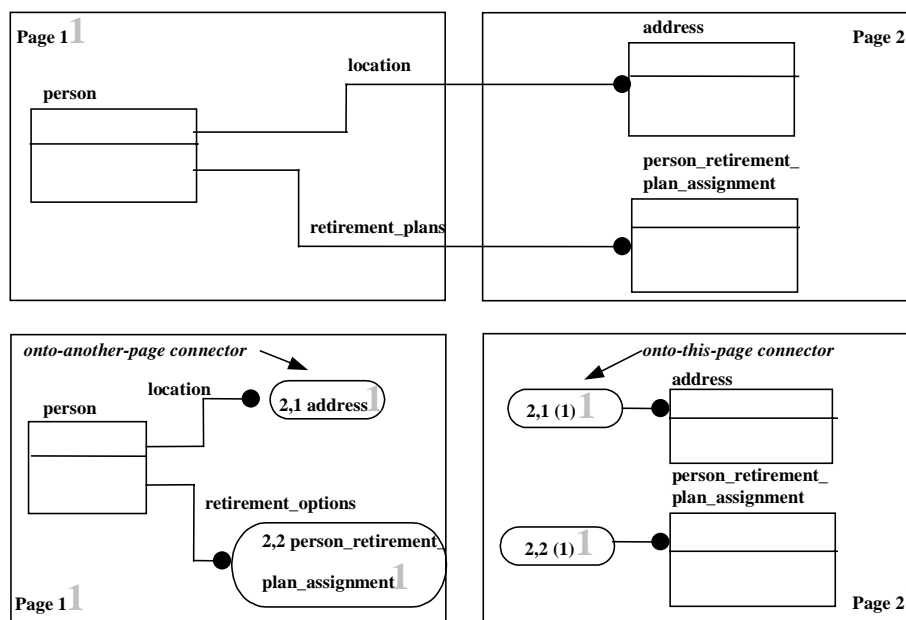


Figure G.1 - Off-page connectors

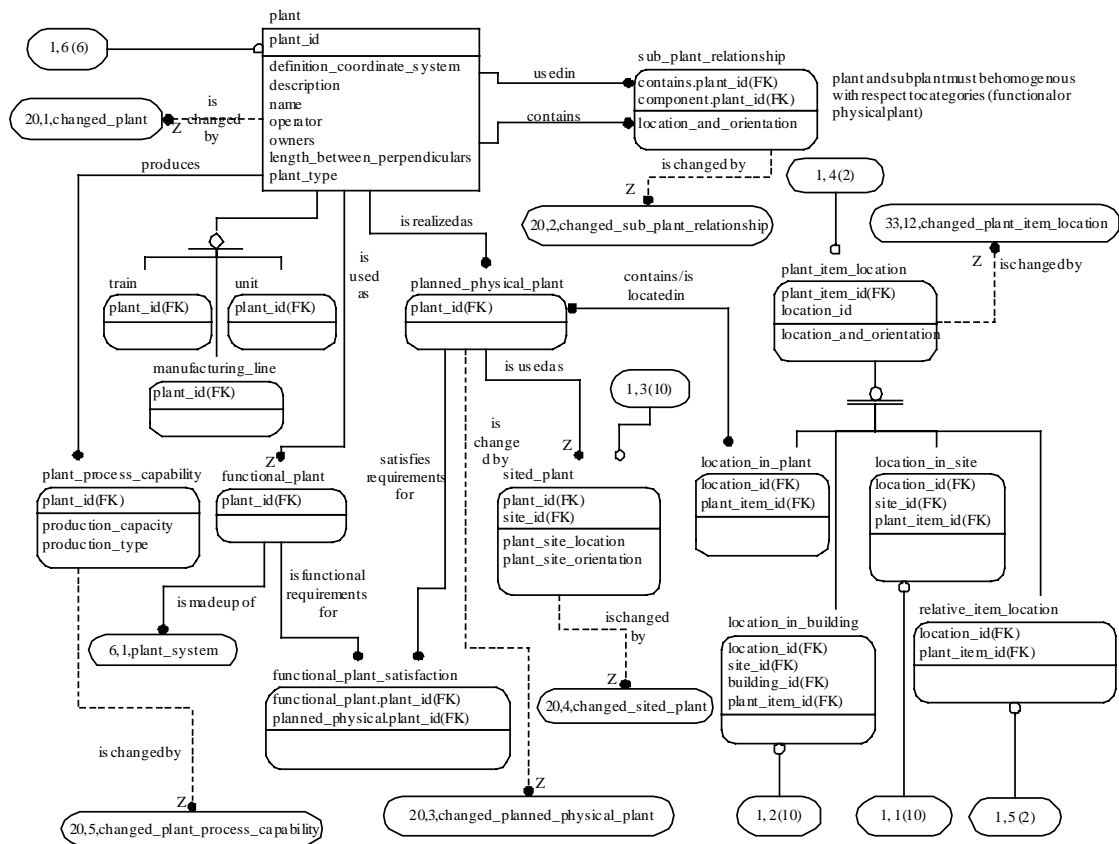
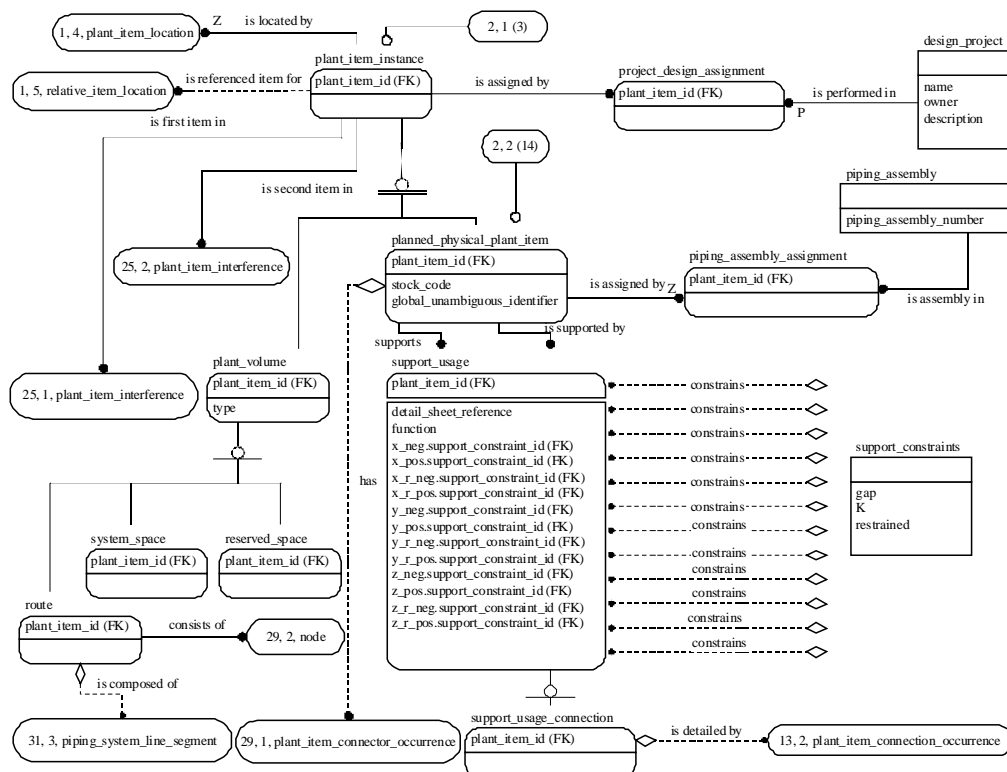


Figure G.2 - ARM diagram 1 of 42



**Figure G.3 - ARM diagram 2 of 42**

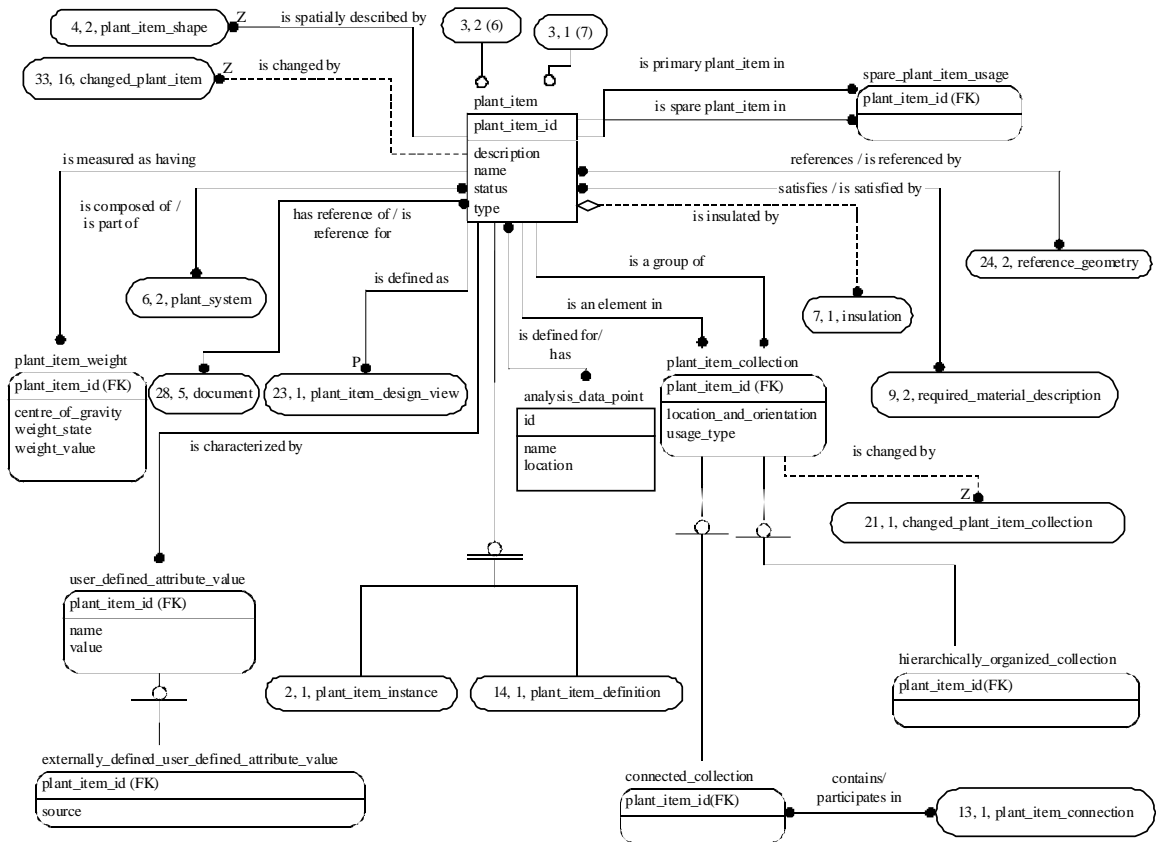


Figure G.4 - ARM diagram 3 of 42

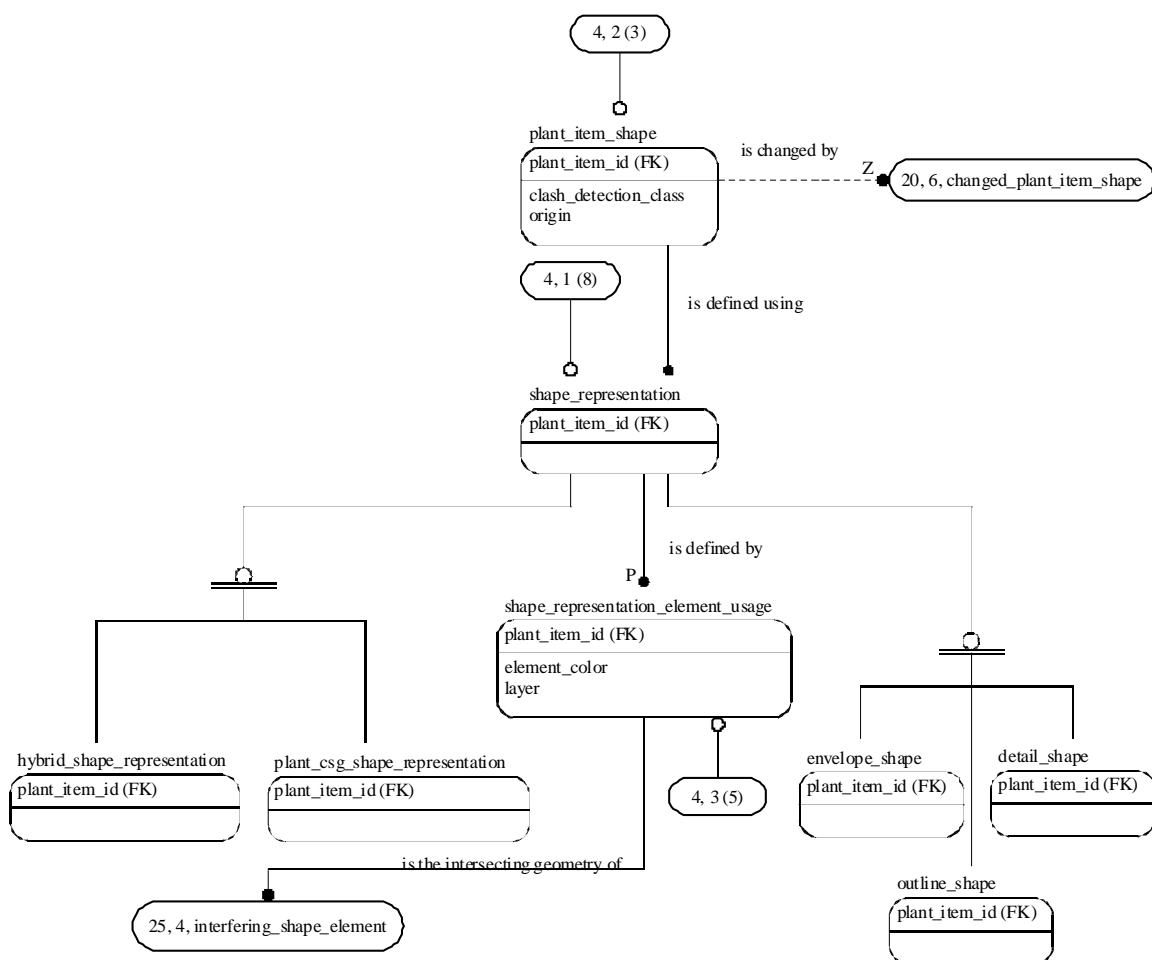


Figure G.5 - ARM diagram 4 of 42

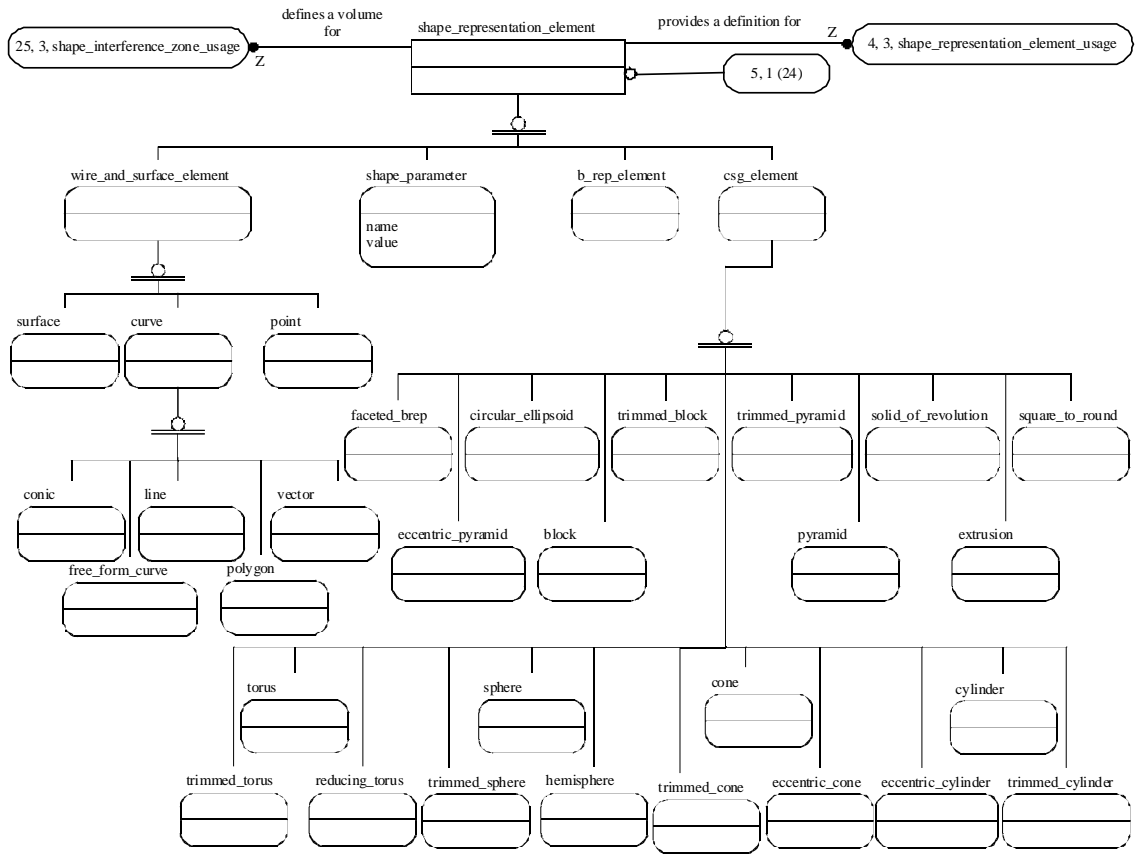


Figure G.6 - ARM diagram 5 of 42

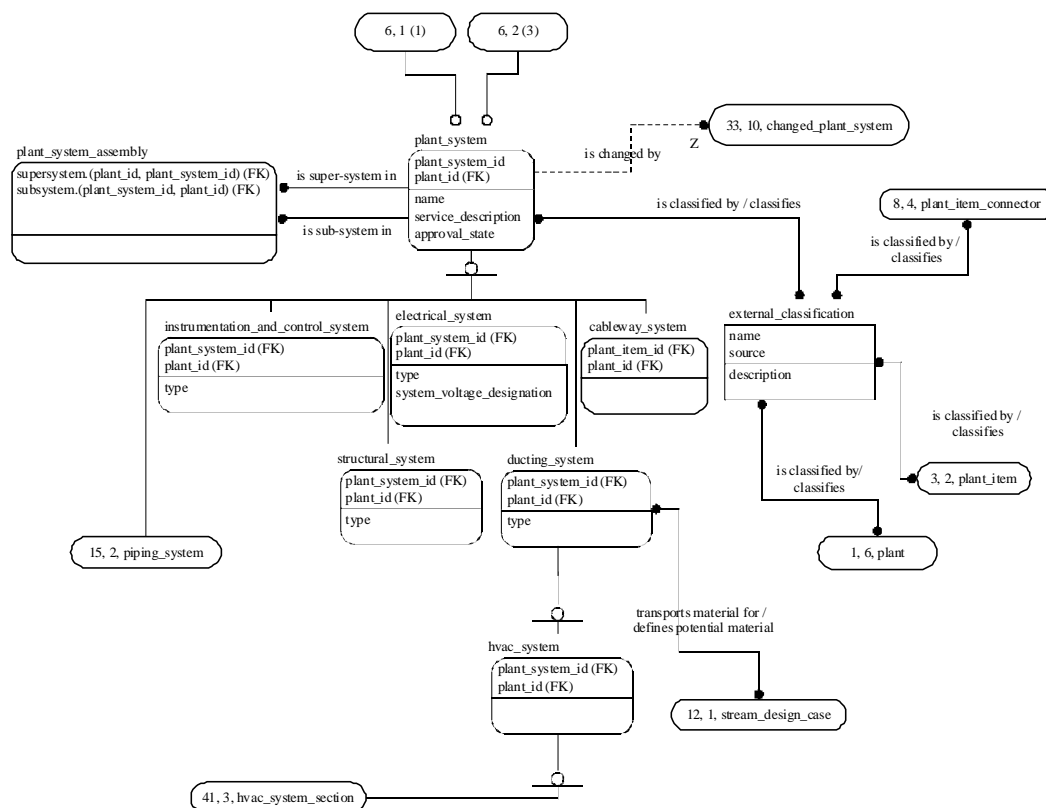


Figure G.7 - ARM diagram 6 of 42

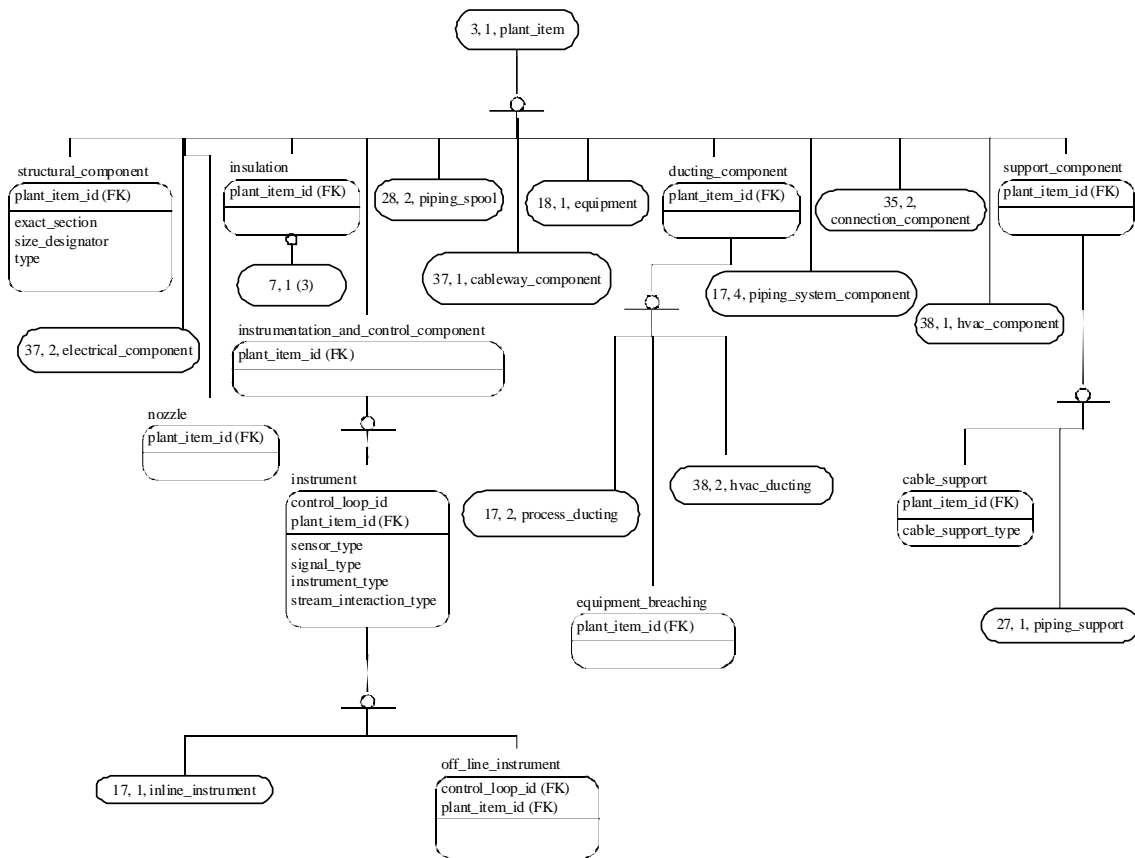
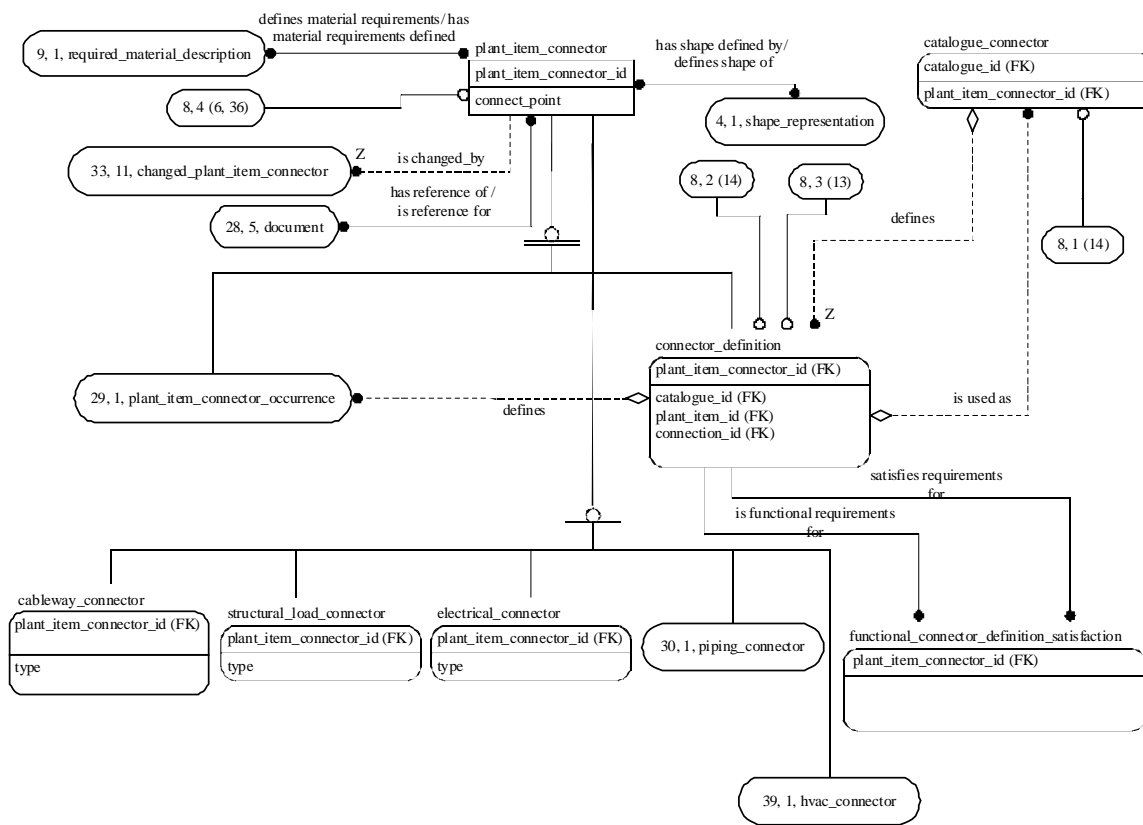


Figure G.8 - ARM diagram 7 of 42



**Figure G.9 - ARM diagram 8 of 42**

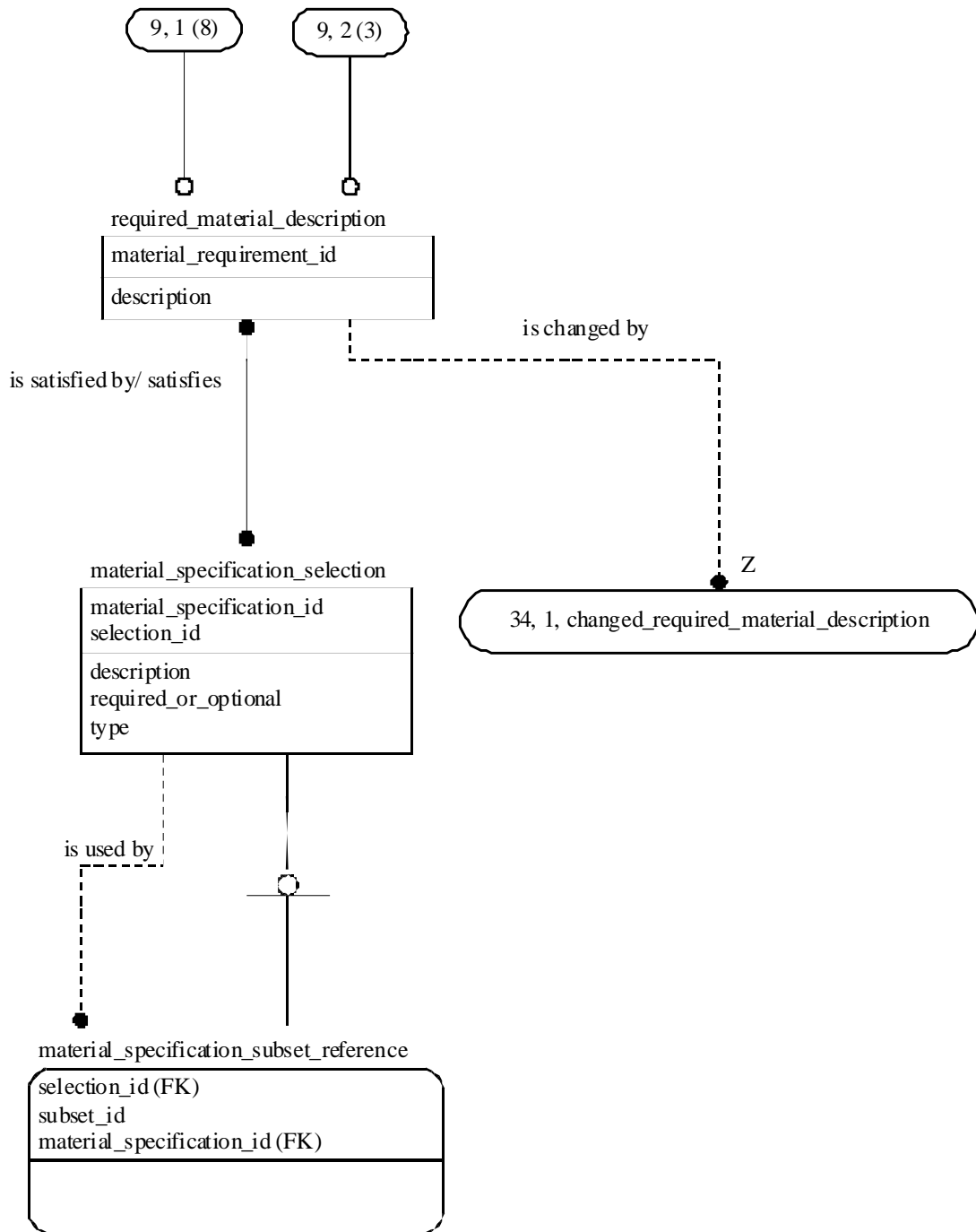


Figure G.10 - ARM diagram 9 of 42

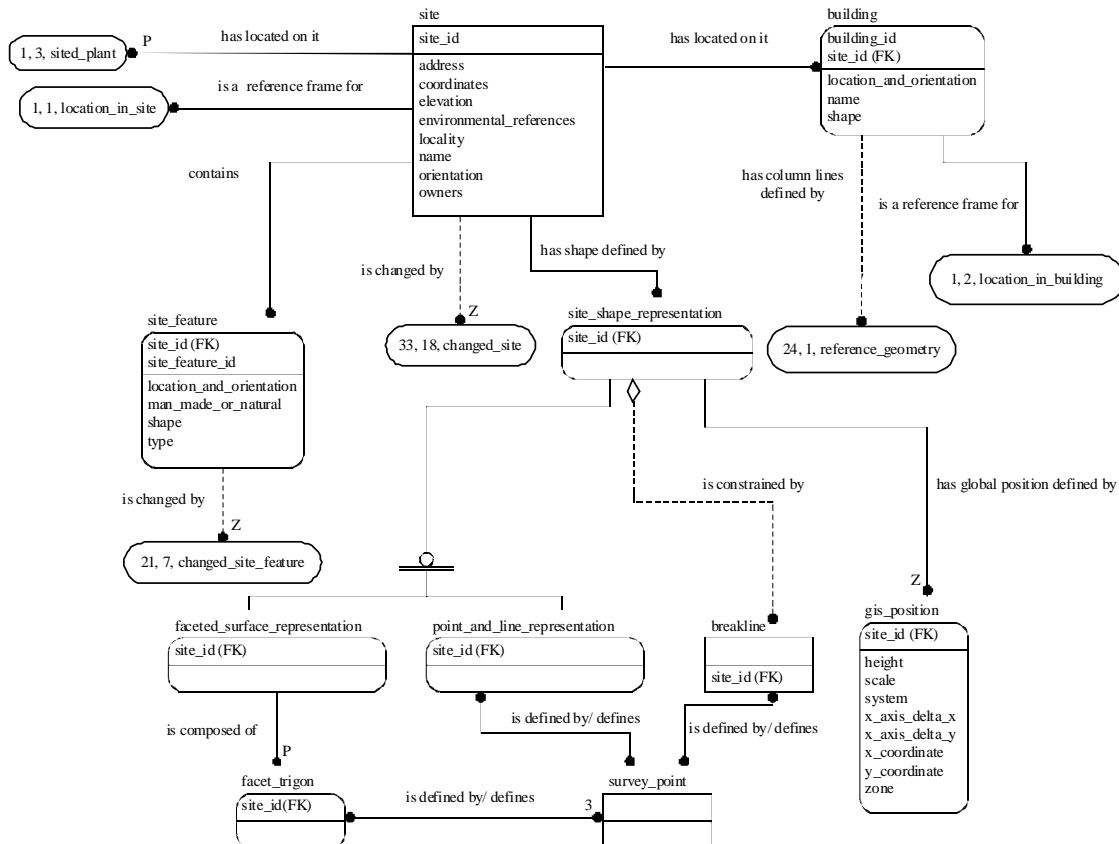


Figure G.11 - ARM diagram 10 of 42

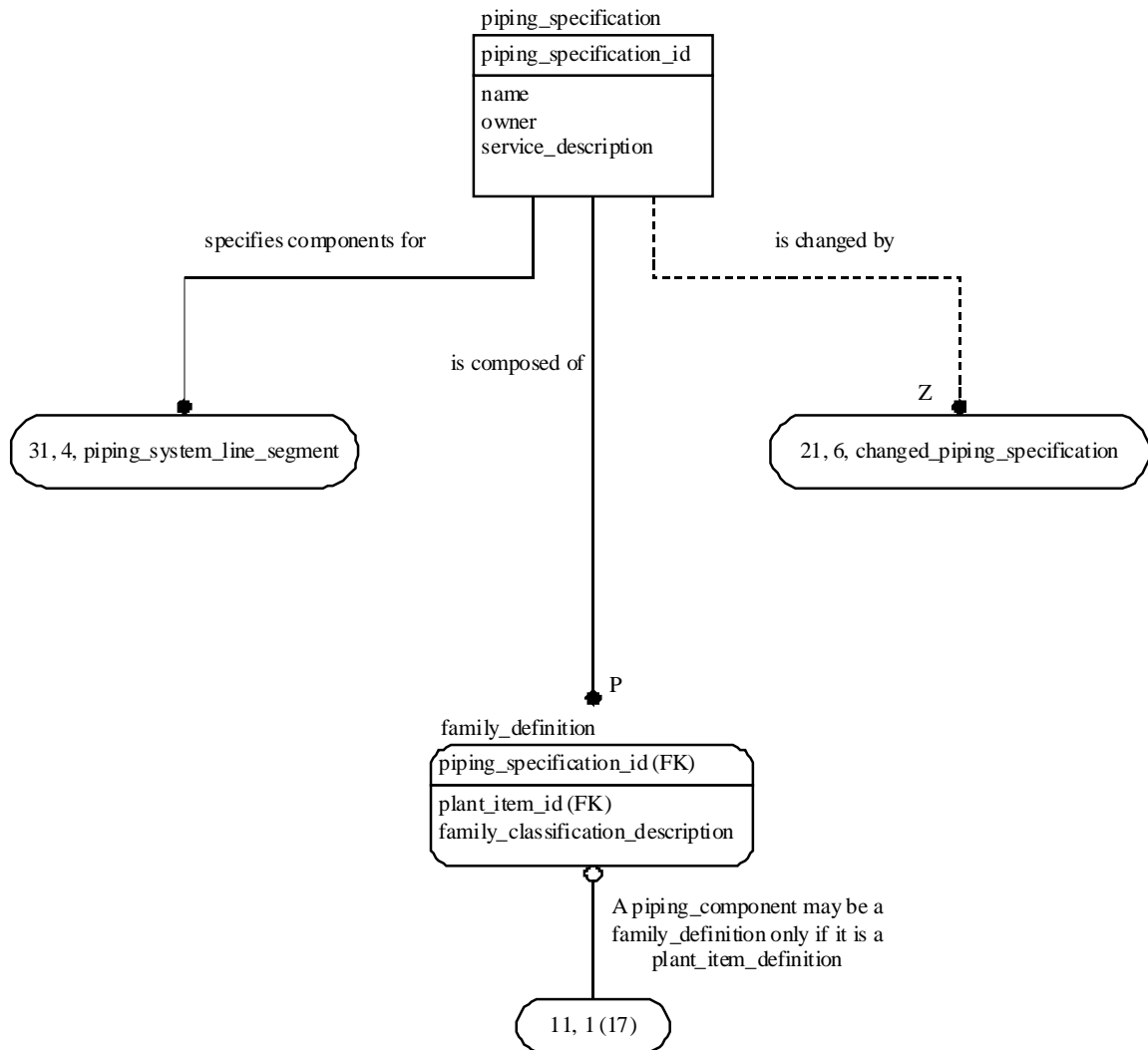


Figure G.12 - ARM diagram 11 of 42

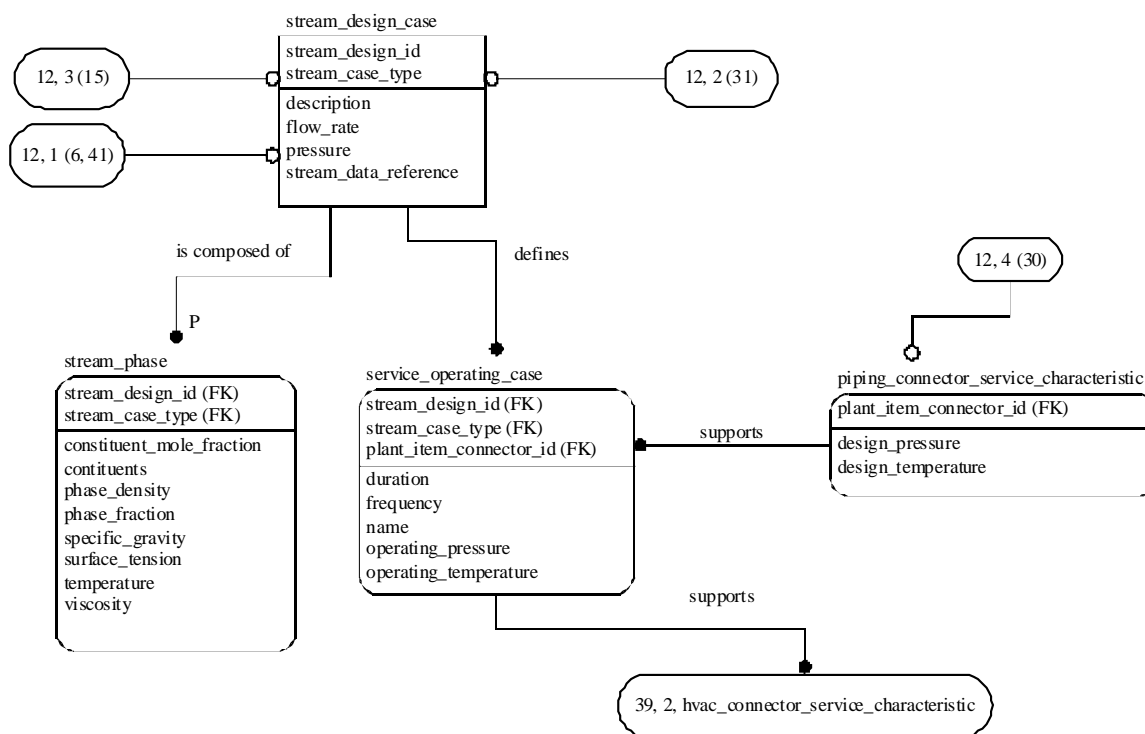


Figure G.13 - ARM diagram 12 of 42

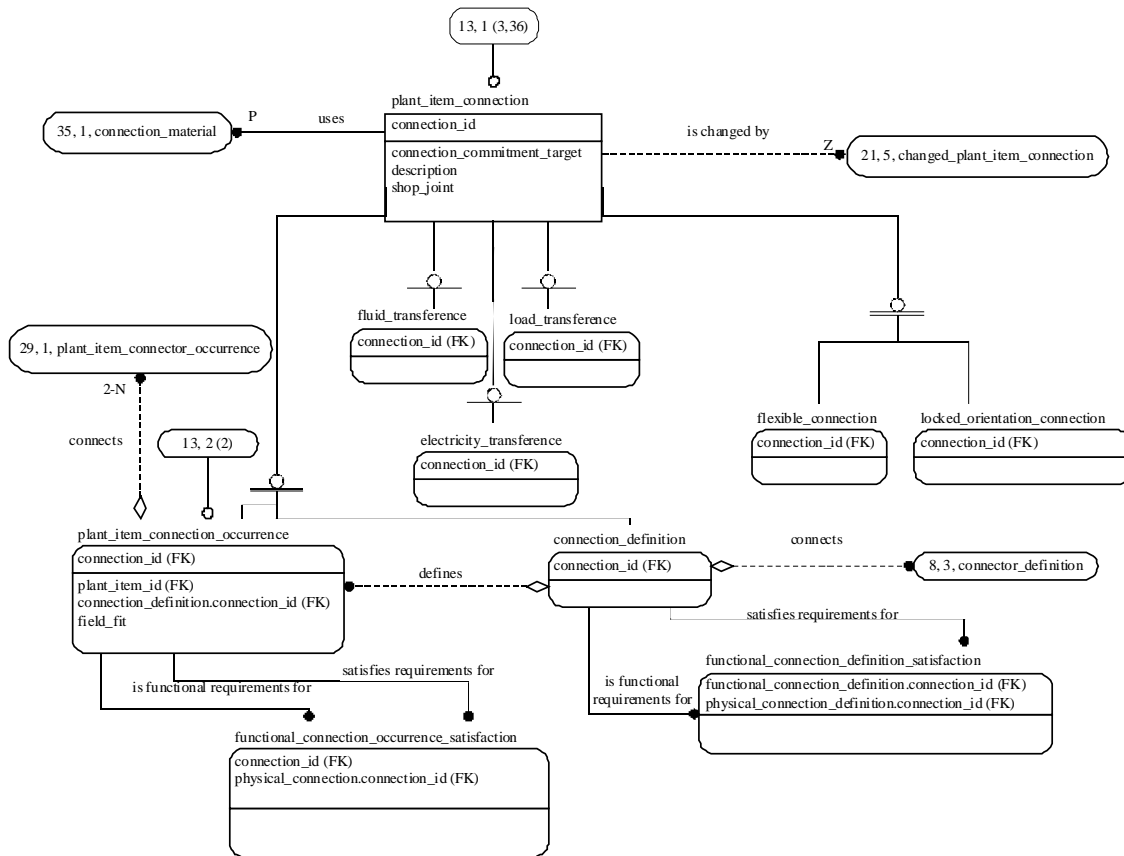


Figure G.14 - ARM diagram 13 of 42

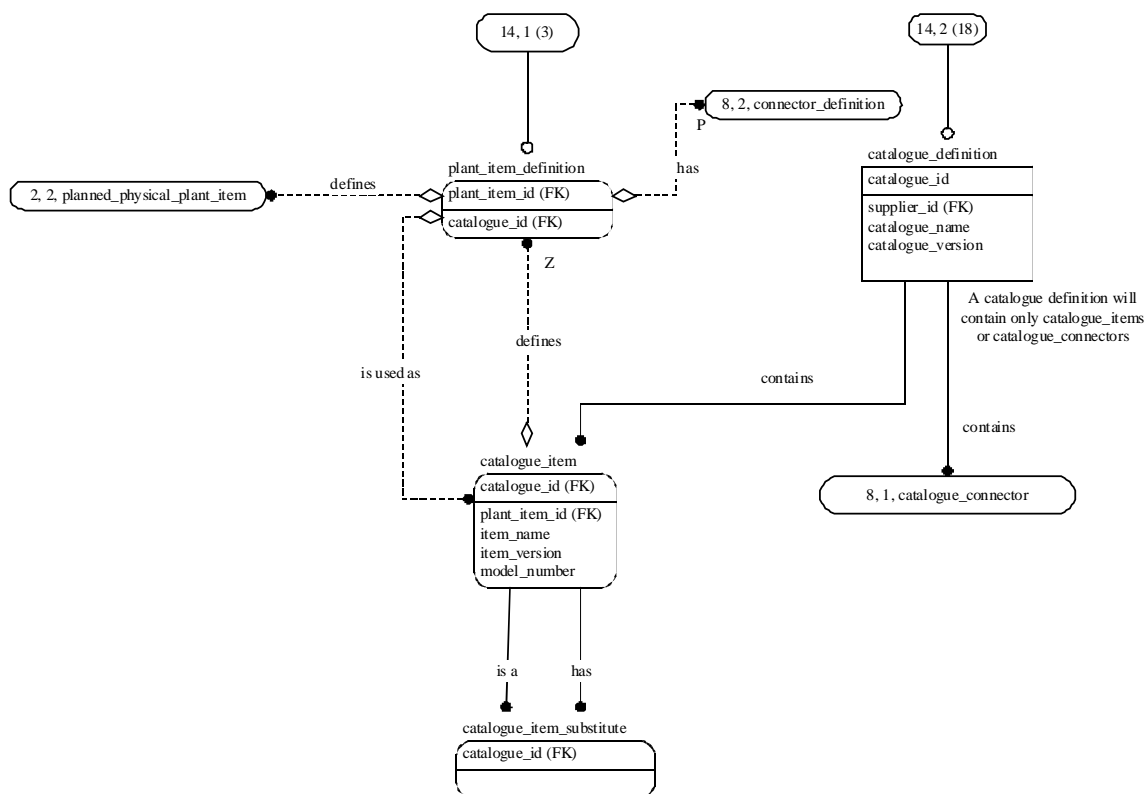


Figure G.15 - ARM diagram 14 of 42

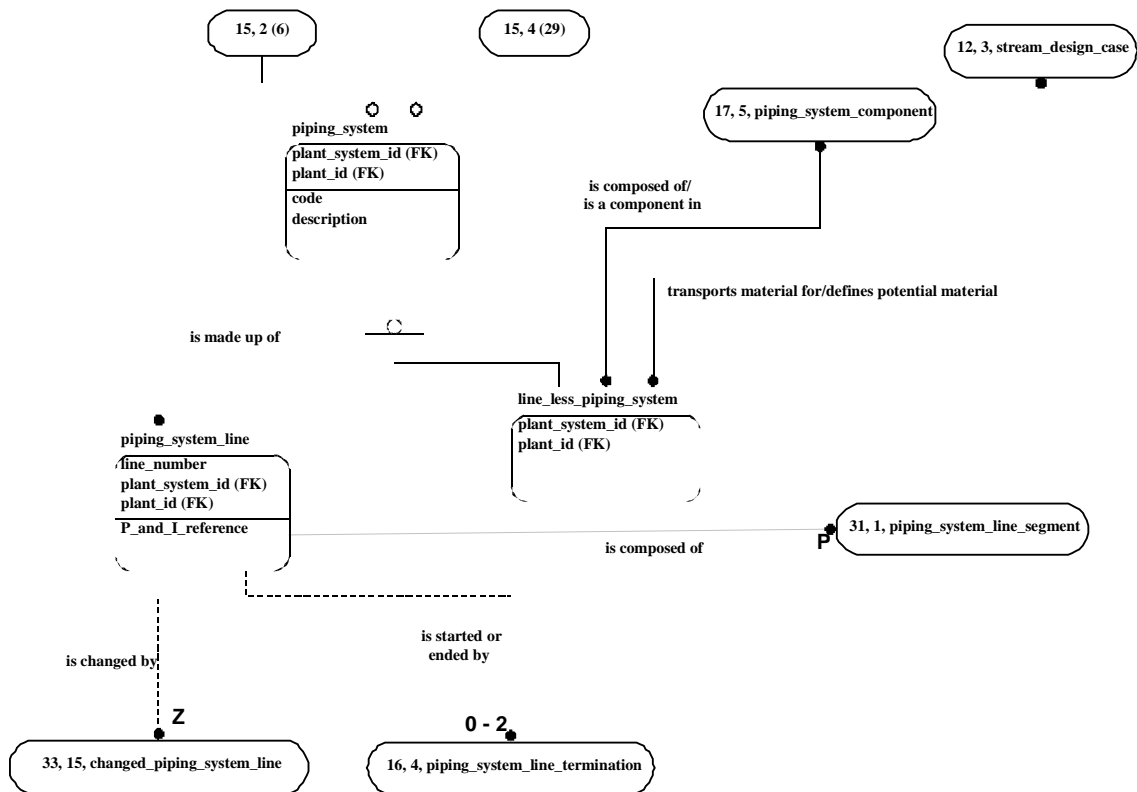


Figure G.16 - ARM diagram 15 of 42

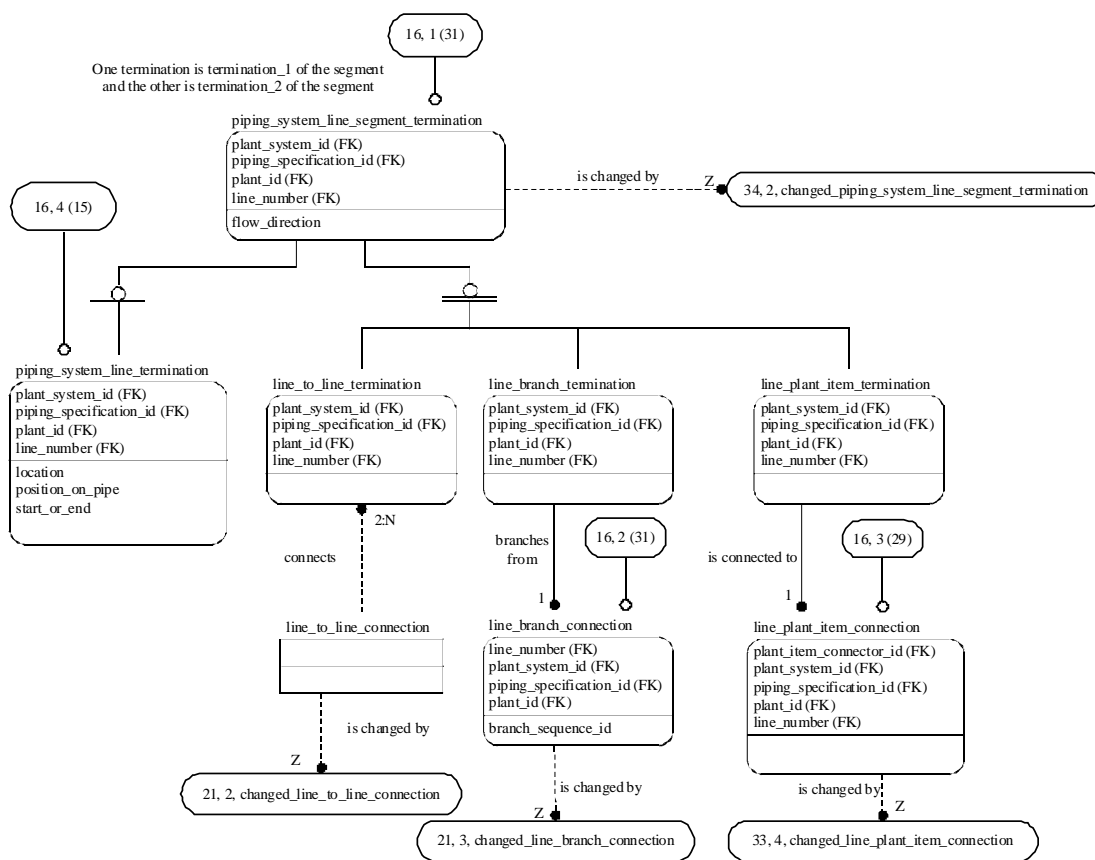


Figure G.17 - ARM diagram 16 of 42

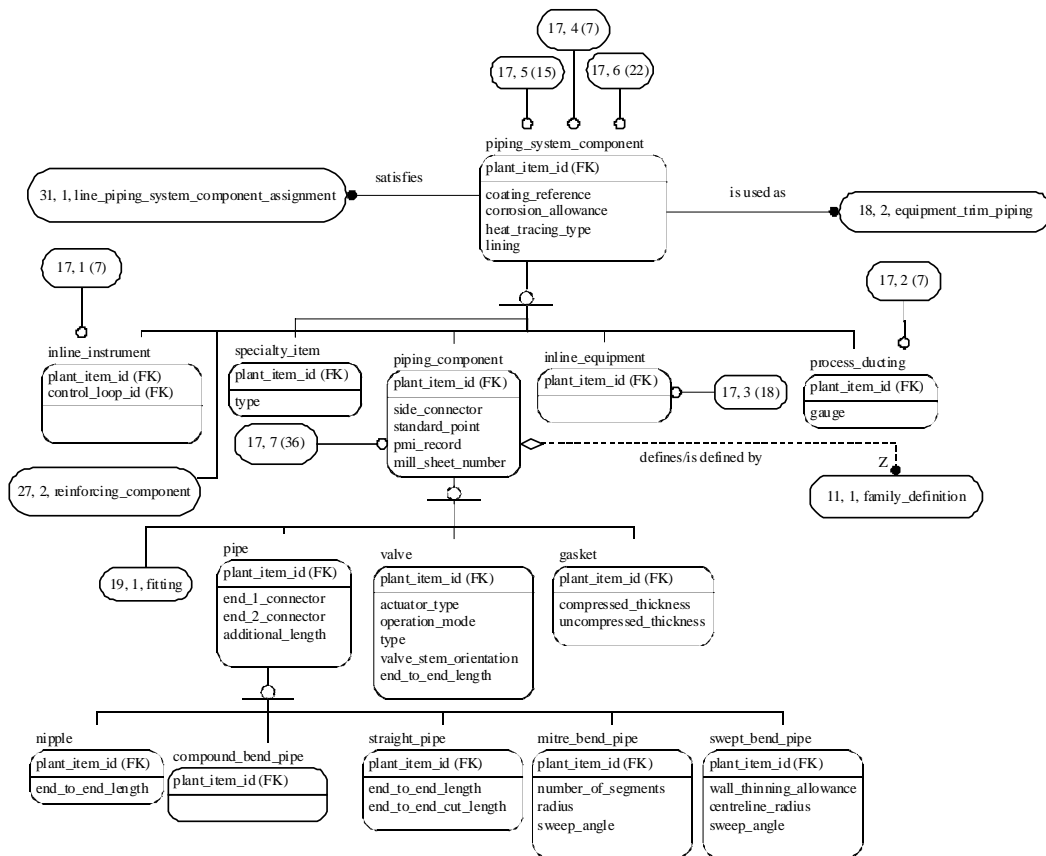


Figure G.18 - ARM diagram 17 of 42

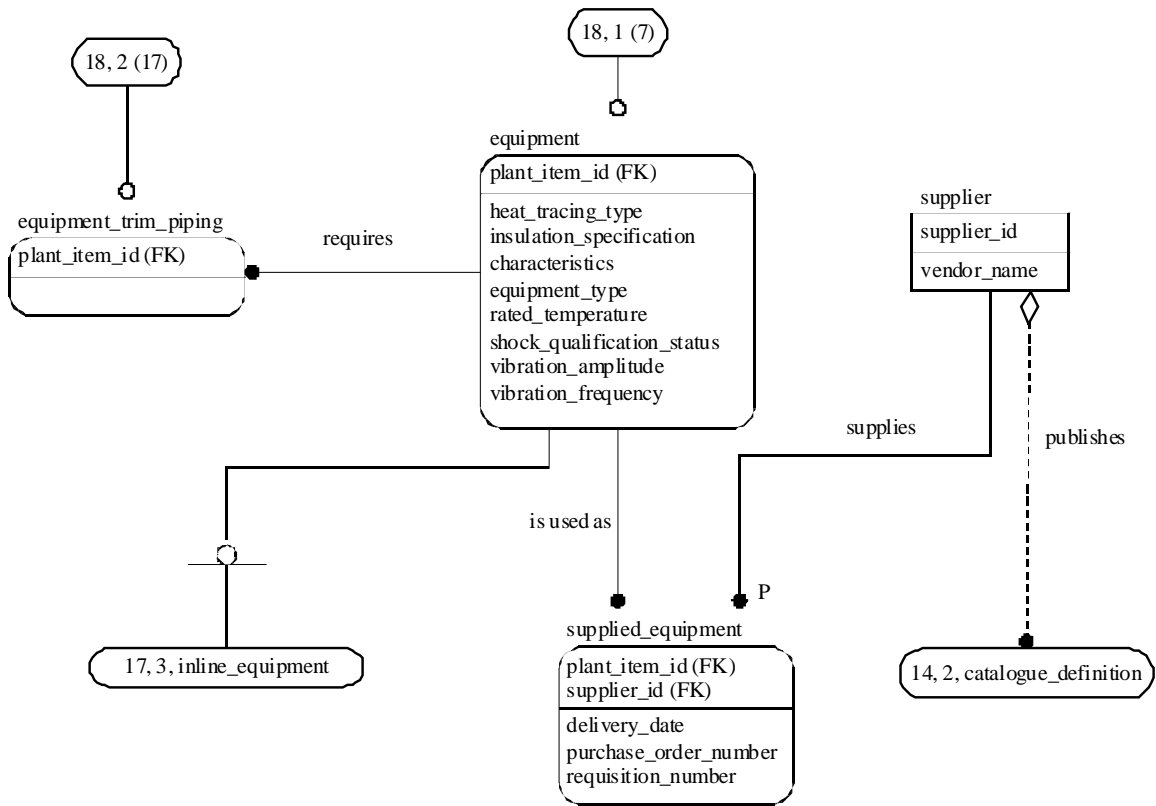


Figure G.19 - ARM diagram 18 of 42

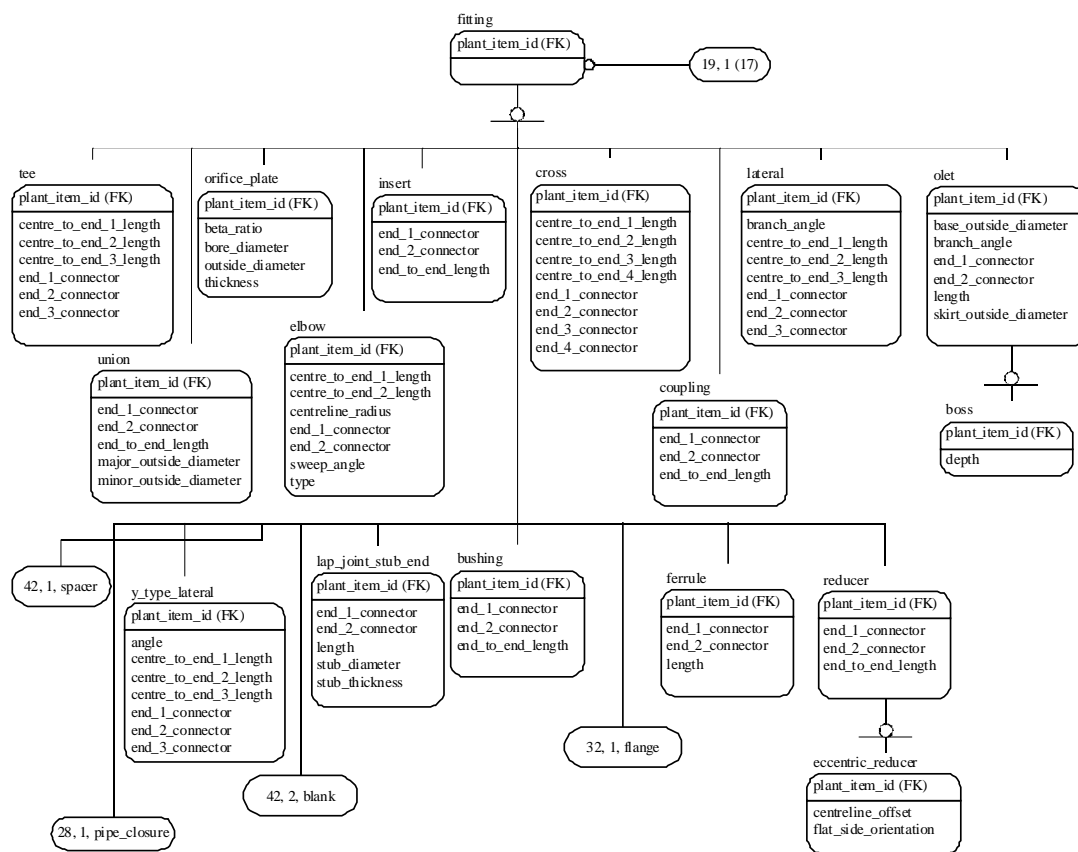


Figure G.20 - ARM diagram 19 of 42

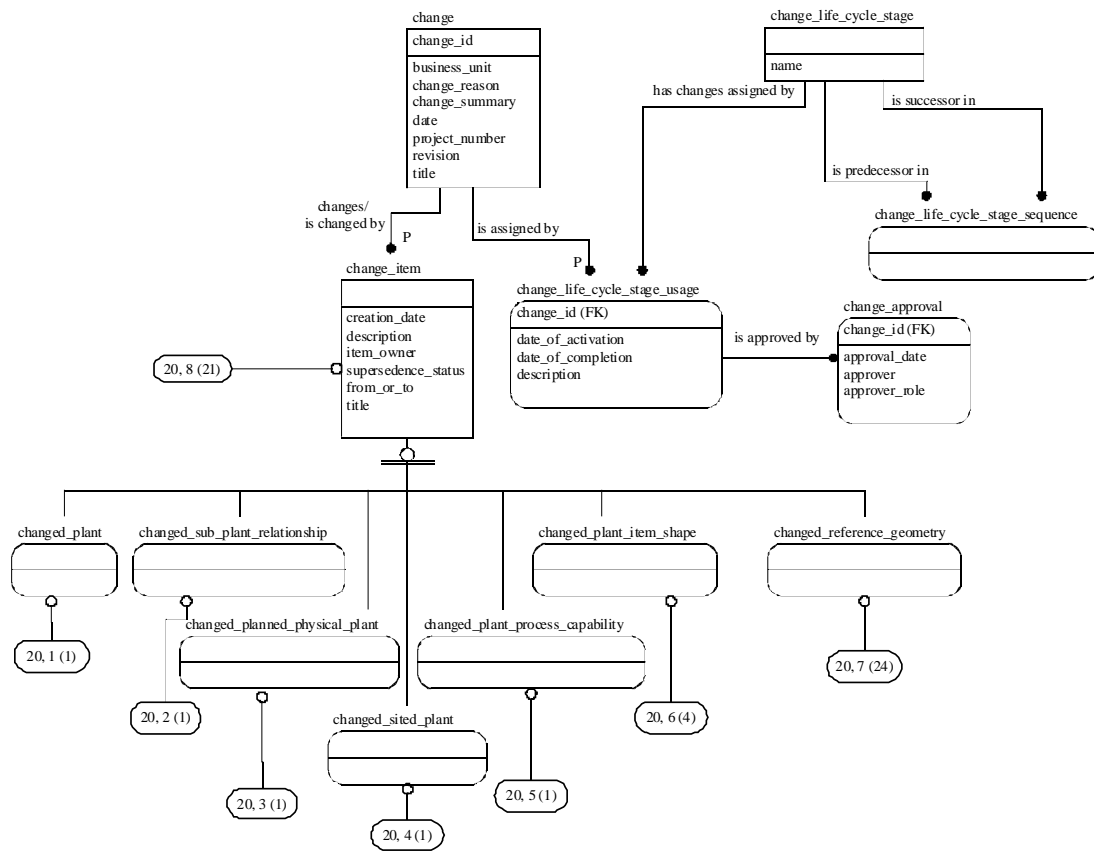
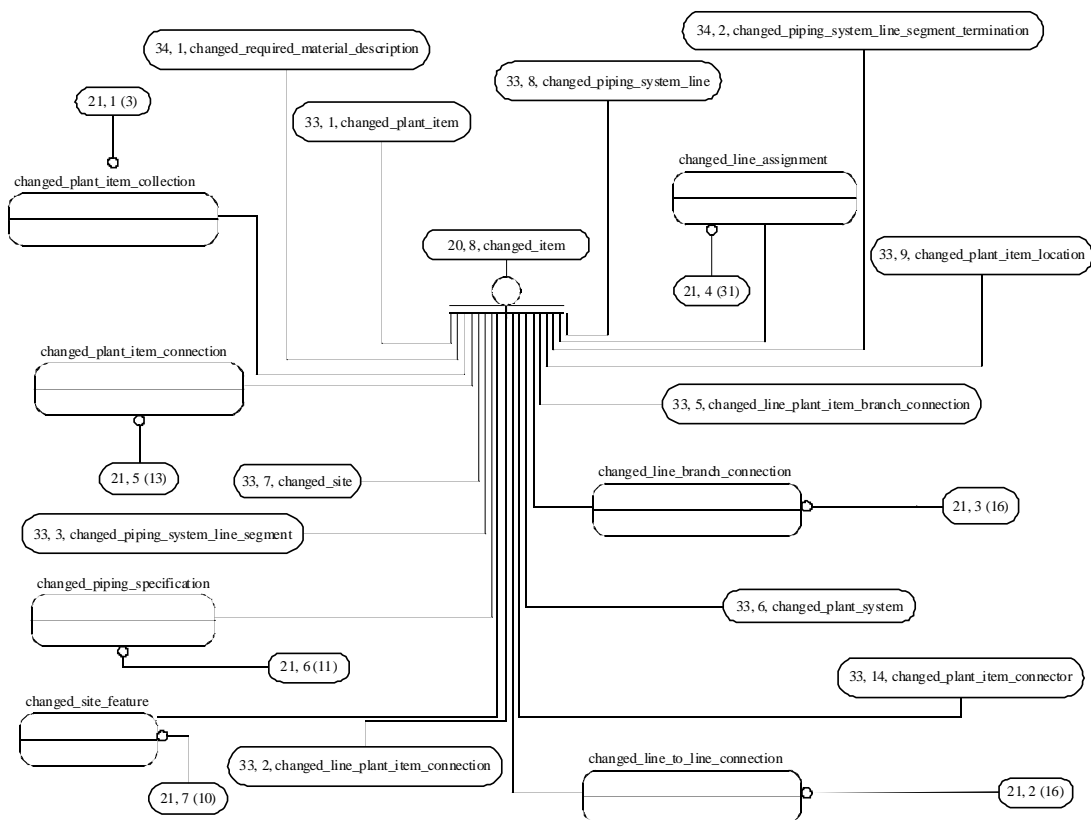


Figure G.21 - ARM diagram 20 of 42



**Figure G.22 - ARM diagram 21 of 42**

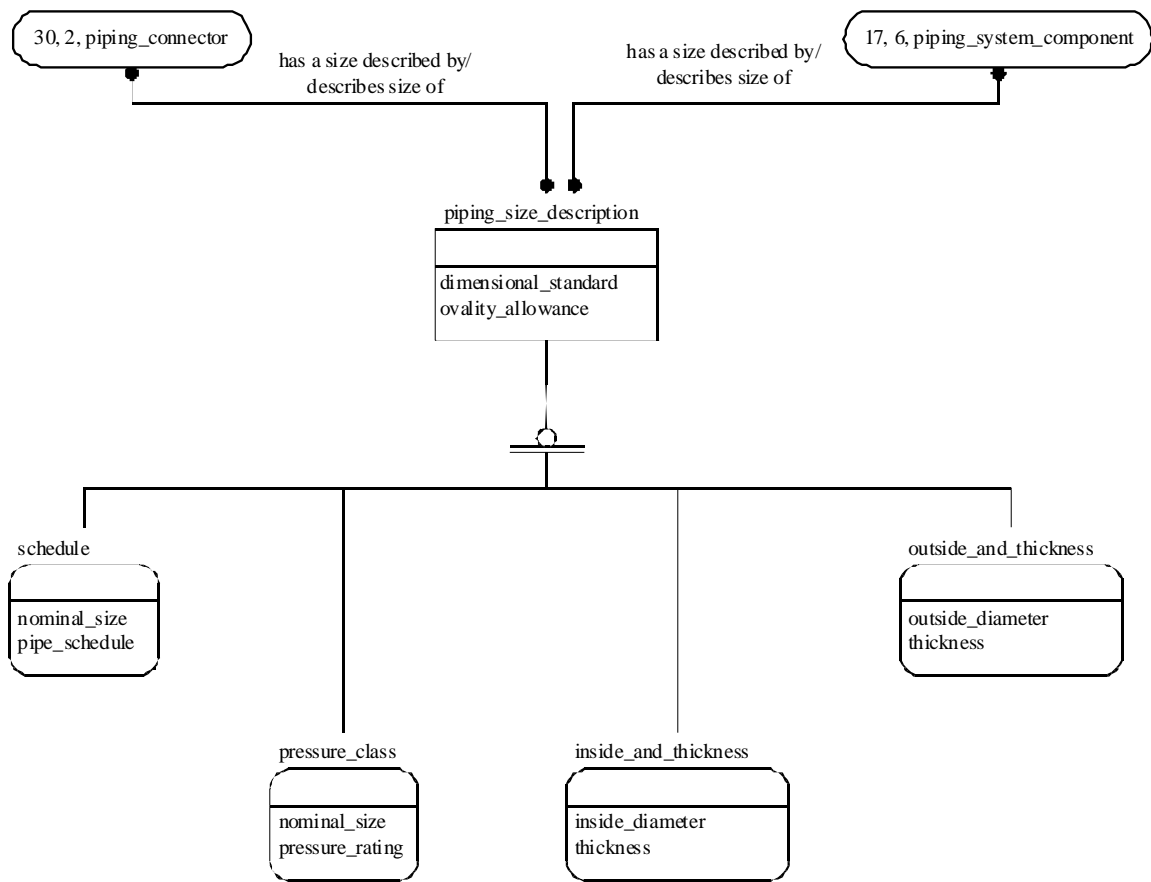


Figure G.23 - ARM diagram 22 of 42

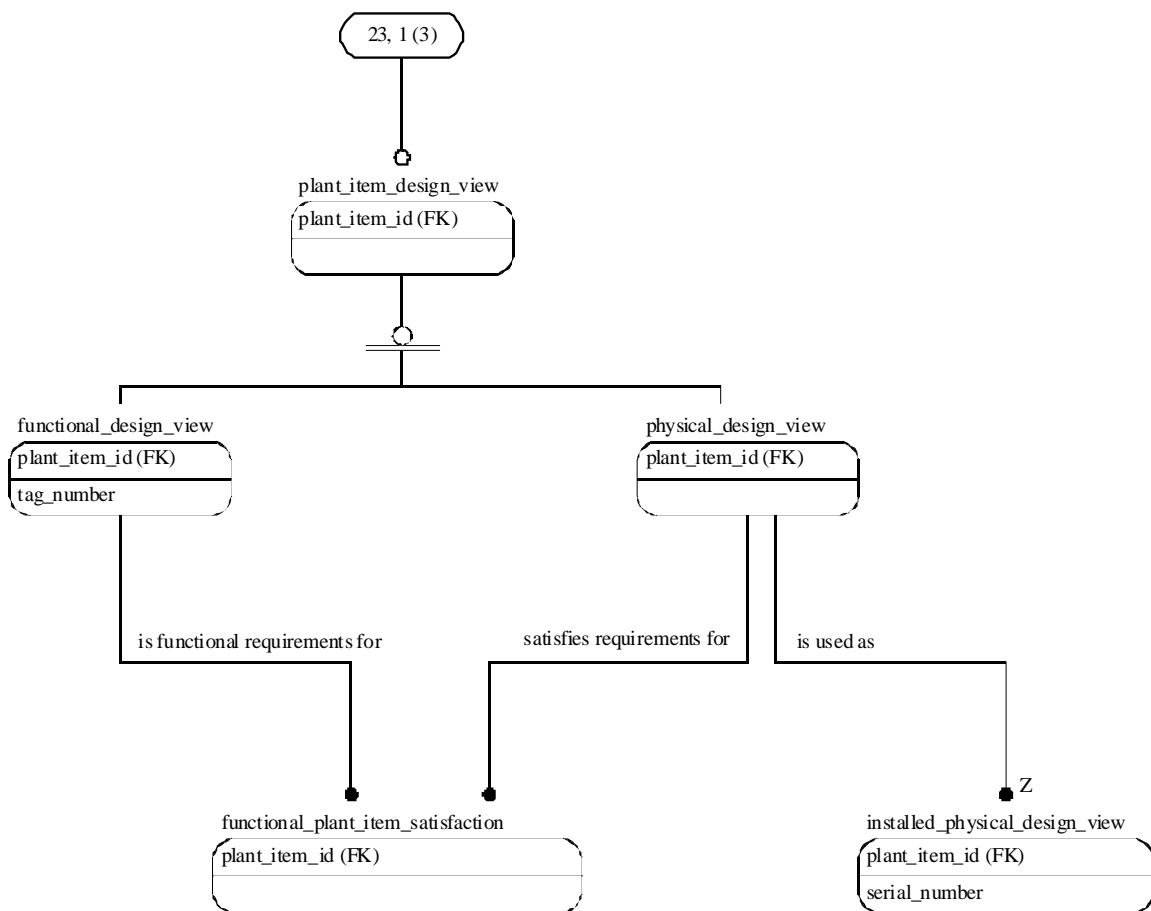


Figure G.24 - ARM diagram 23 of 42

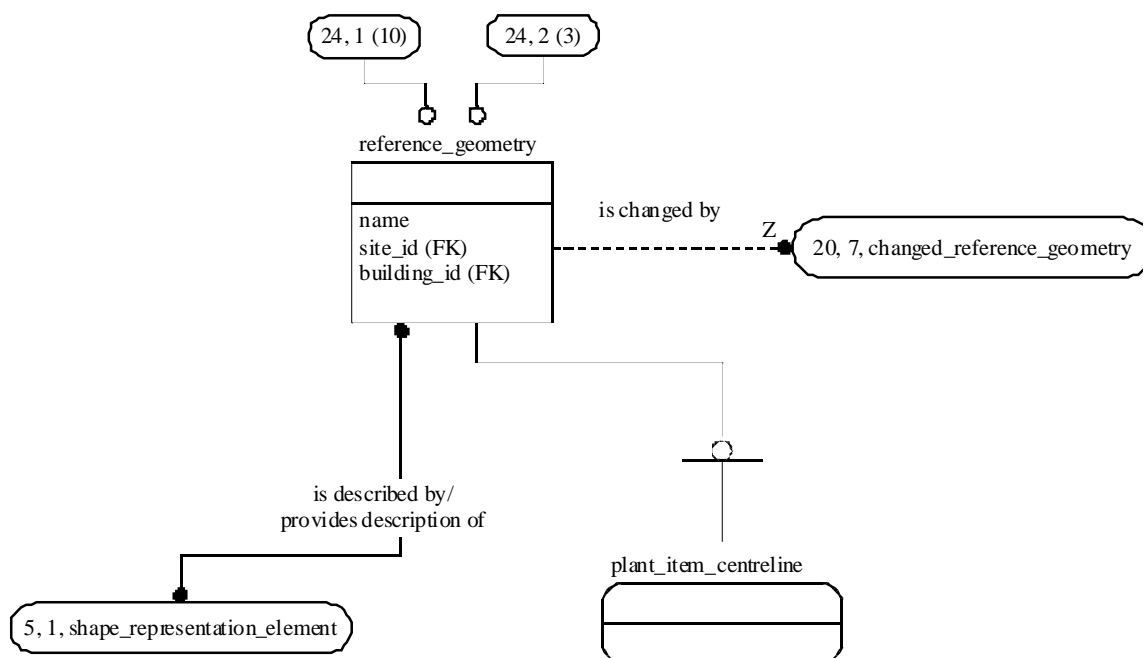


Figure G.25 - ARM diagram 24 of 42

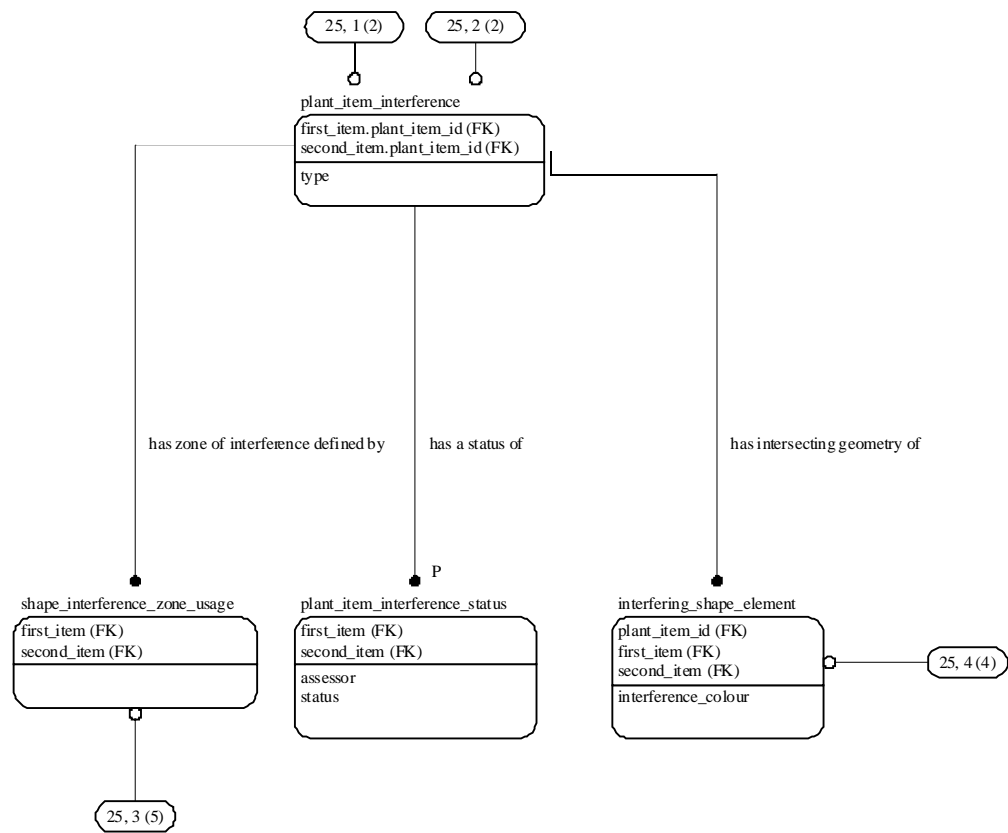


Figure G.26 - ARM diagram 25 of 42

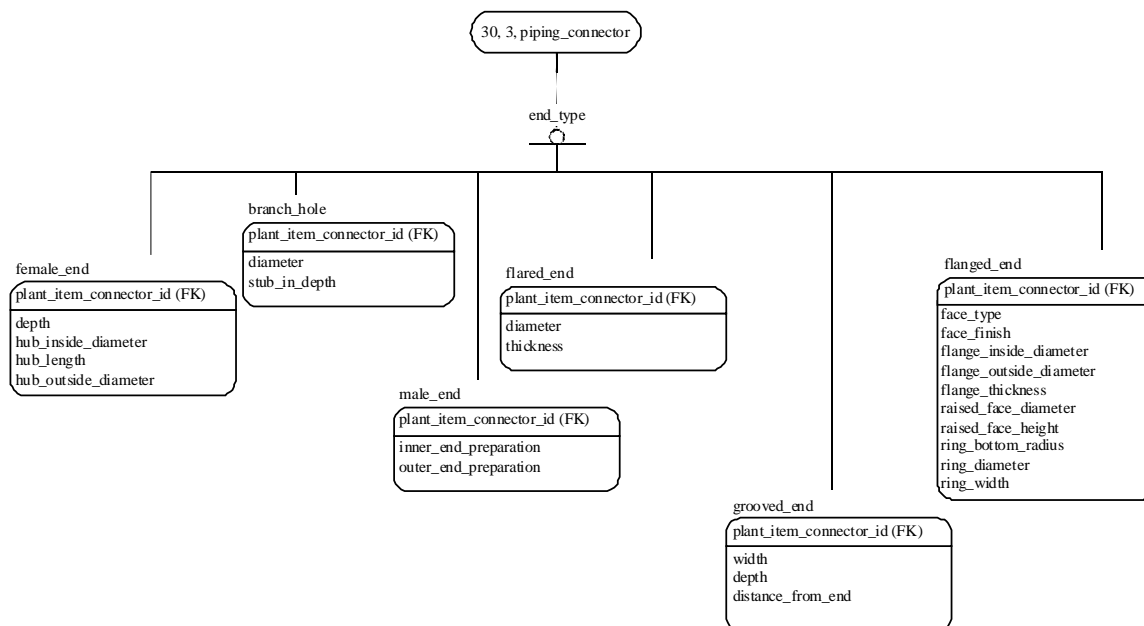


Figure G.27 - ARM diagram 26 of 42

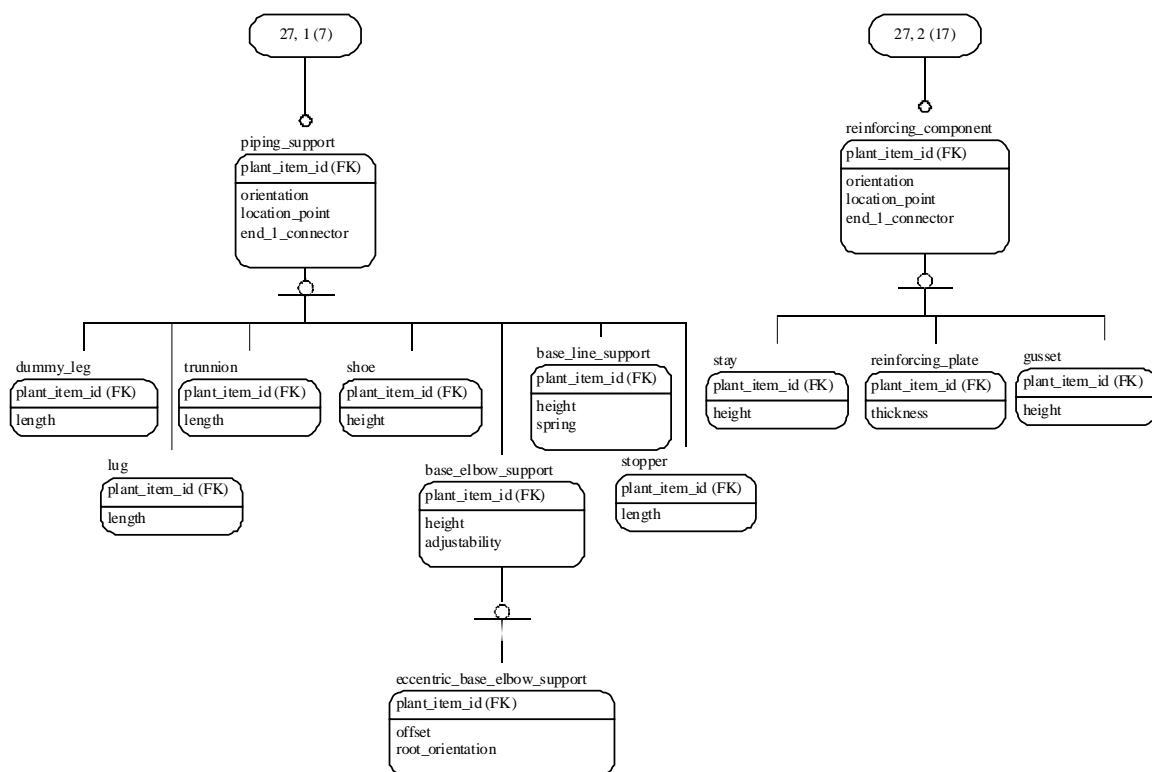


Figure G.28 - ARM diagram 27 of 42

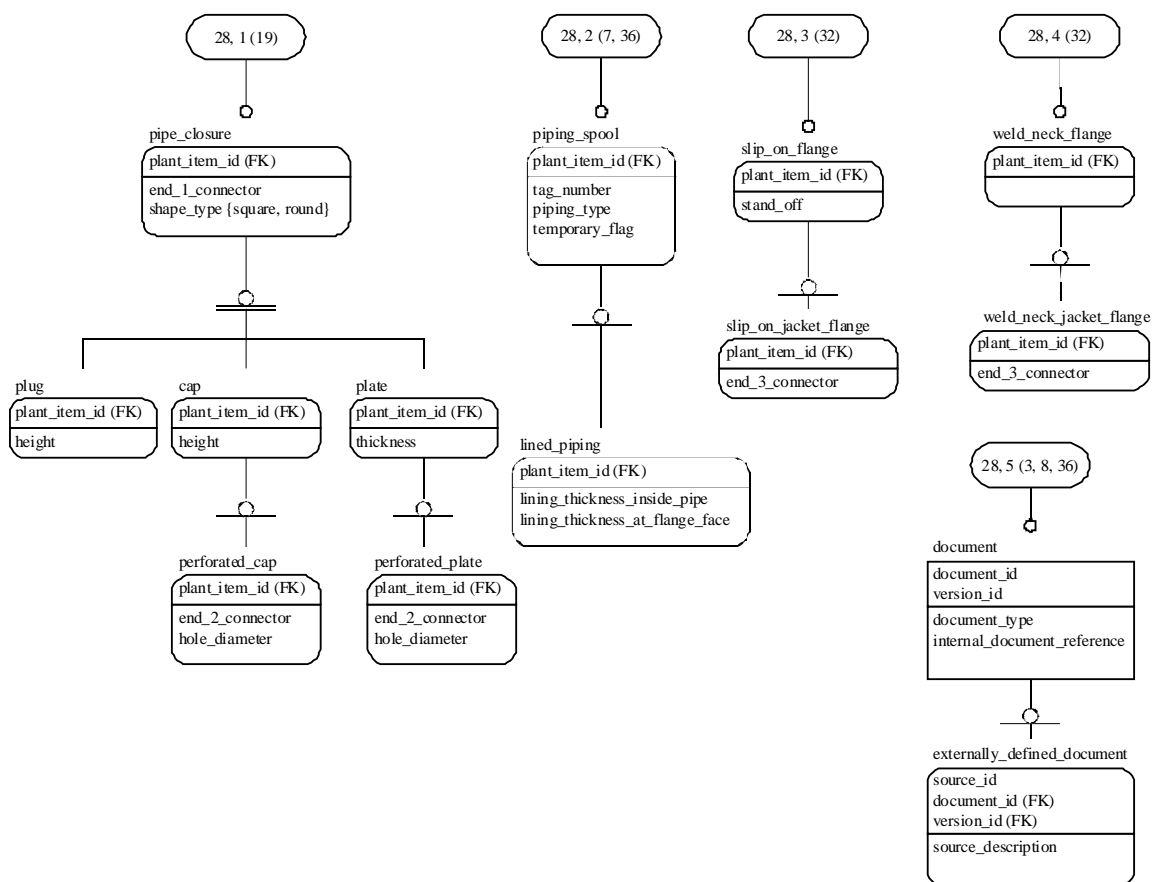


Figure G.29 - ARM diagram 28 of 42

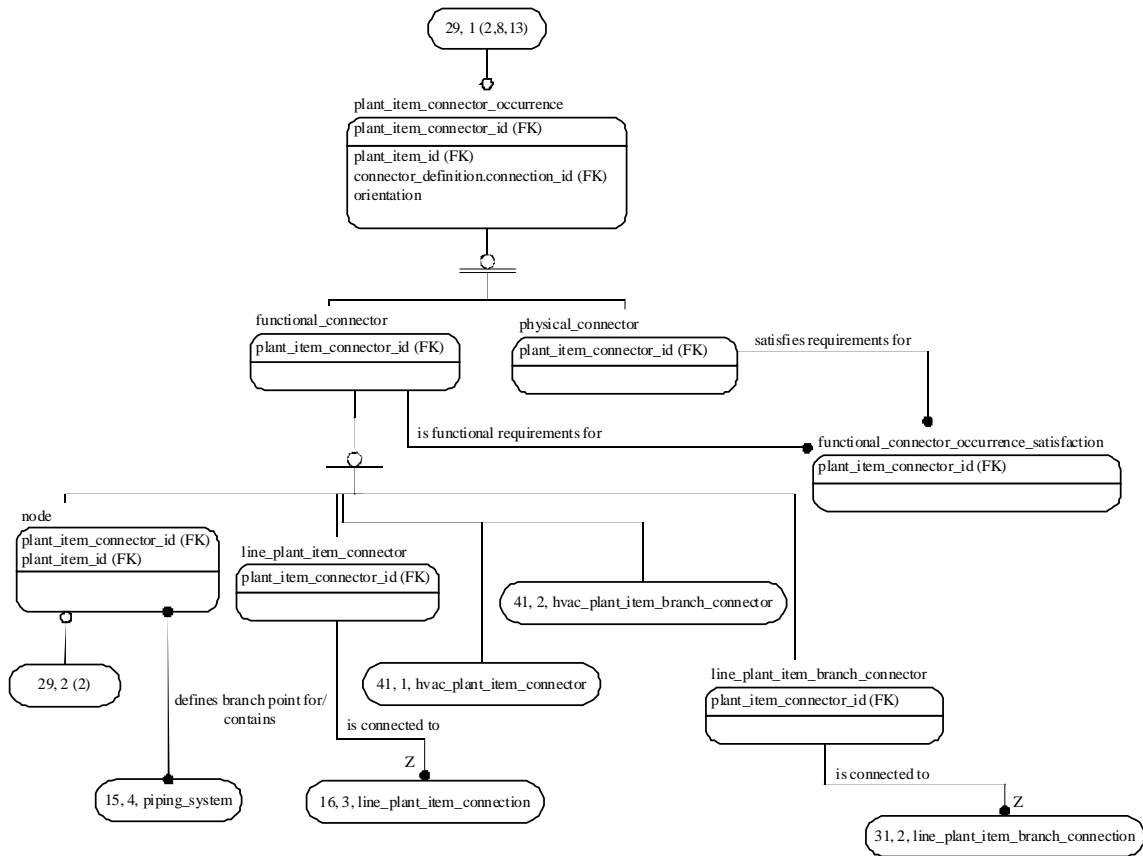


Figure G.30 - ARM diagram 29 of 42

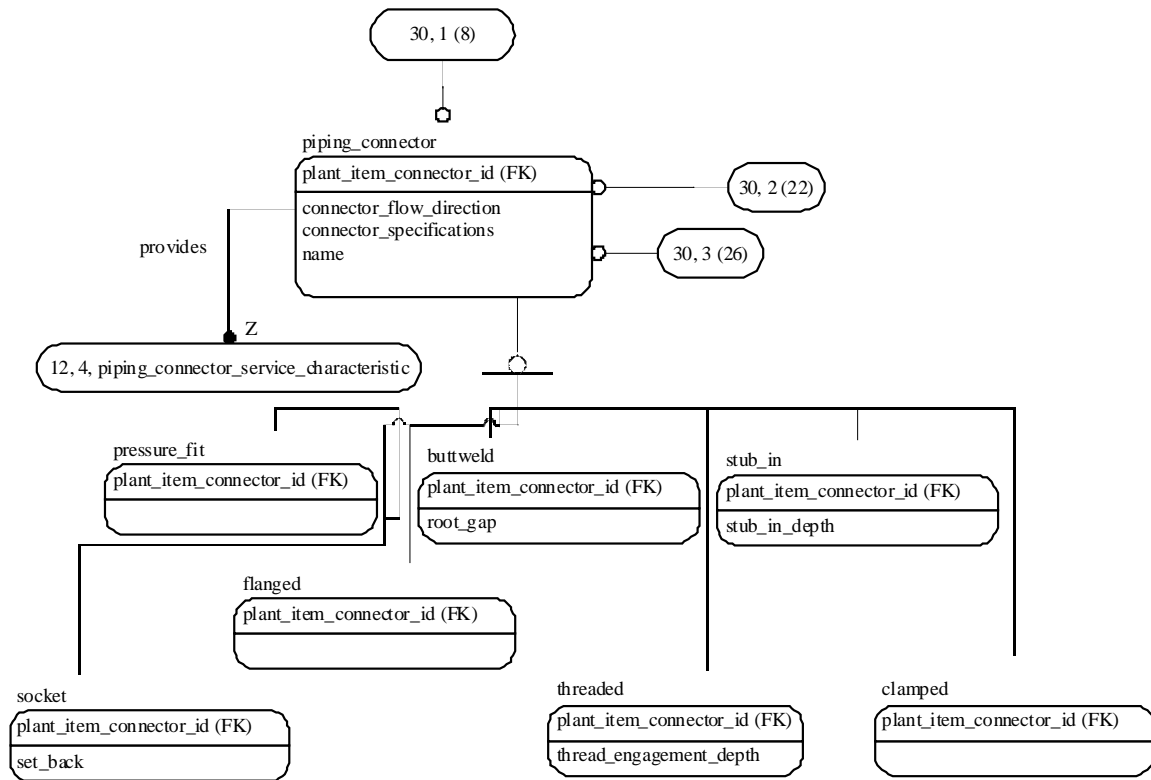


Figure G.31 - ARM diagram 30 or 42

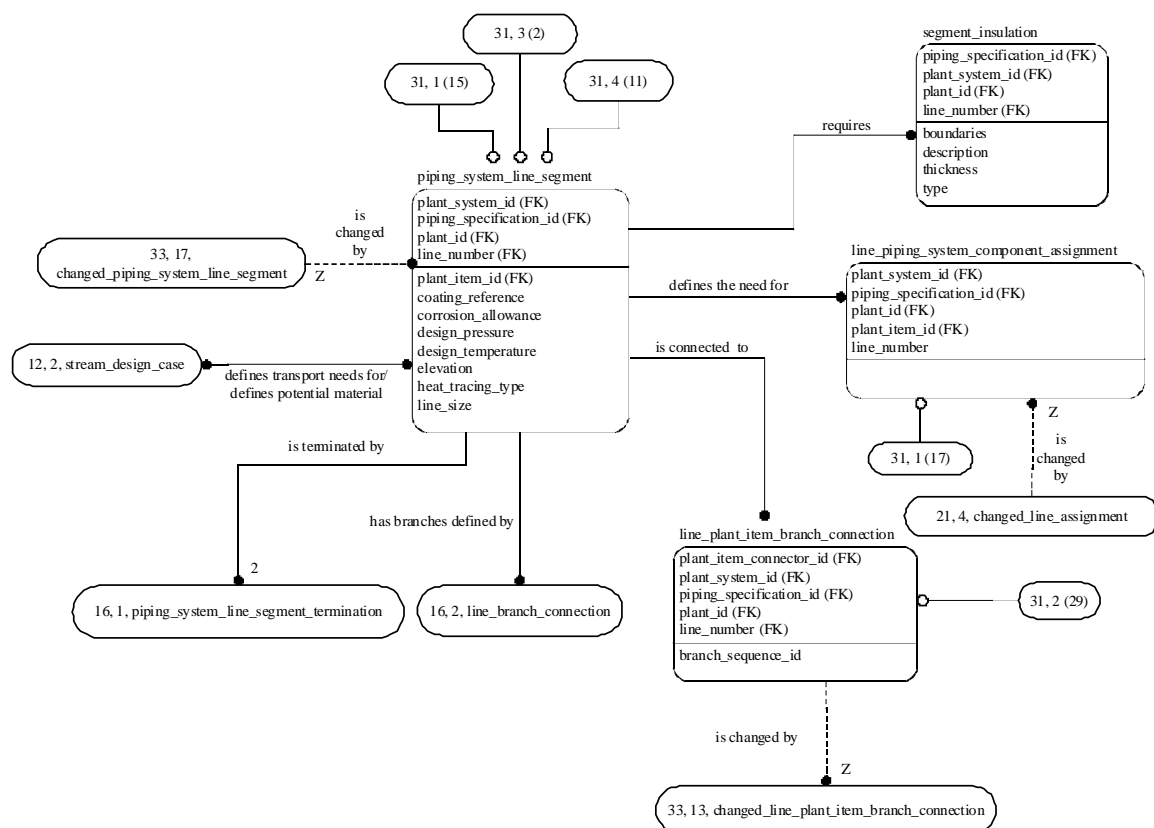


Figure G.32 - ARM diagram 31 of 42

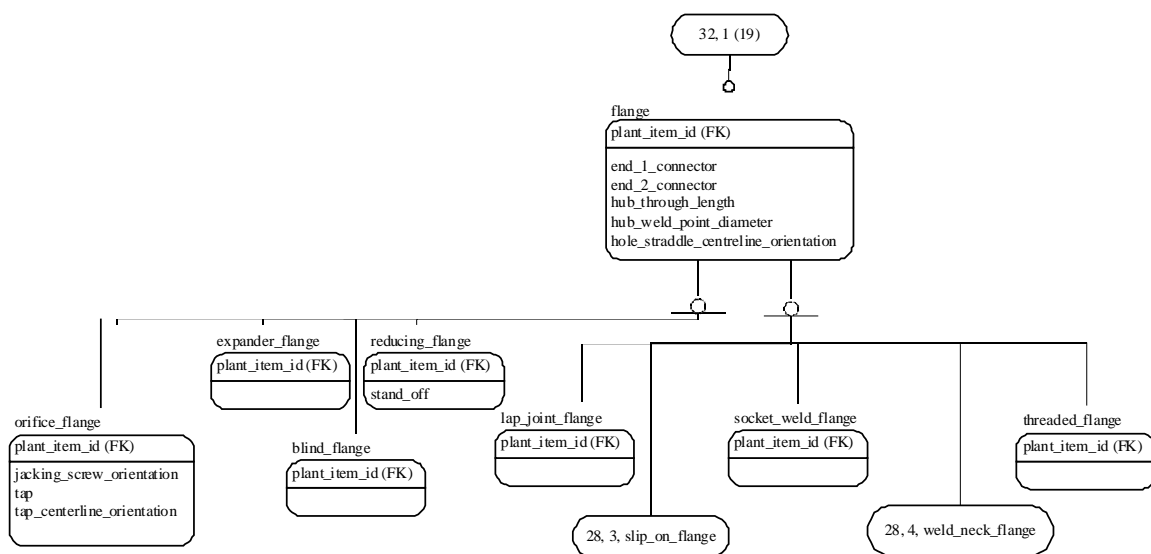
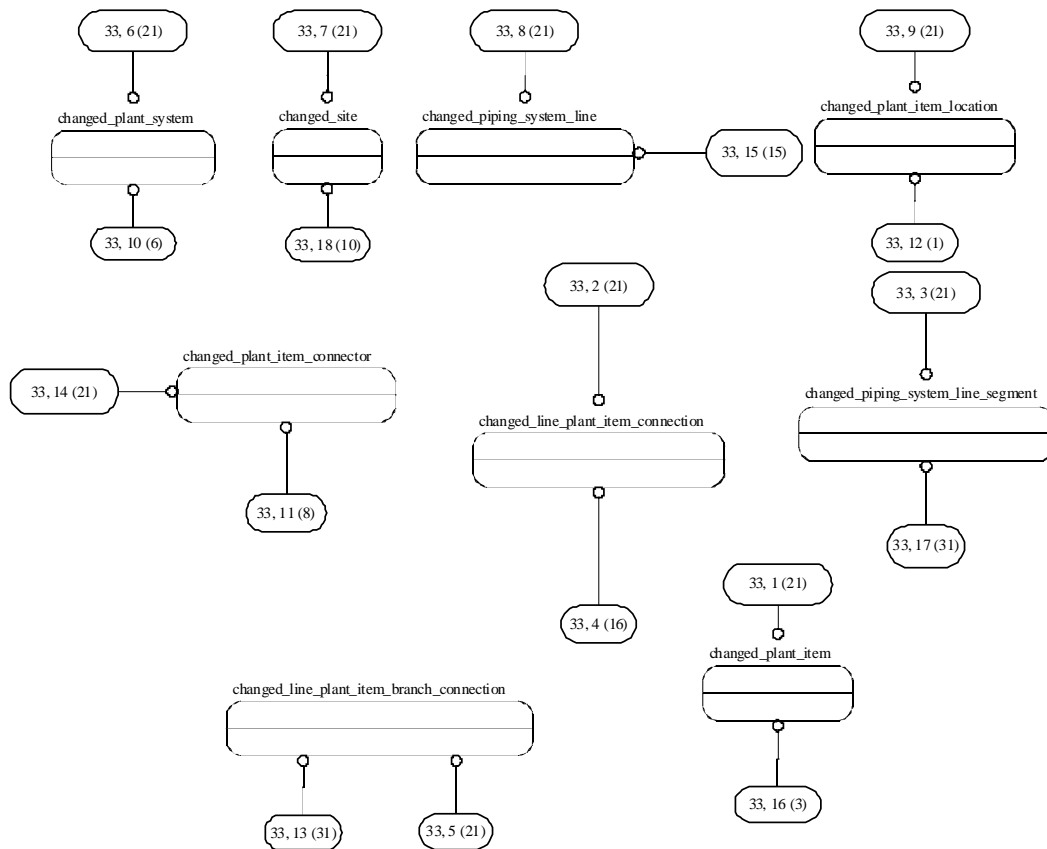


Figure G.33 - ARM diagram 32 of 42



**Figure G.34 - ARM diagram 33 of 42**

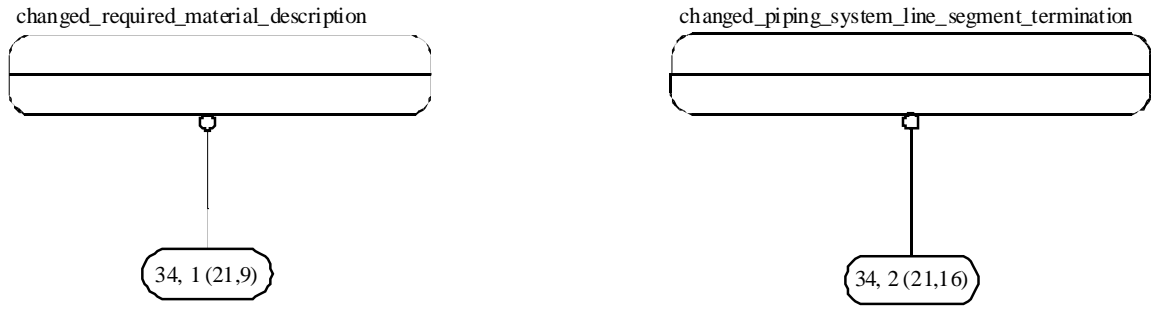


Figure G.35 - ARM diagram 34 of 42

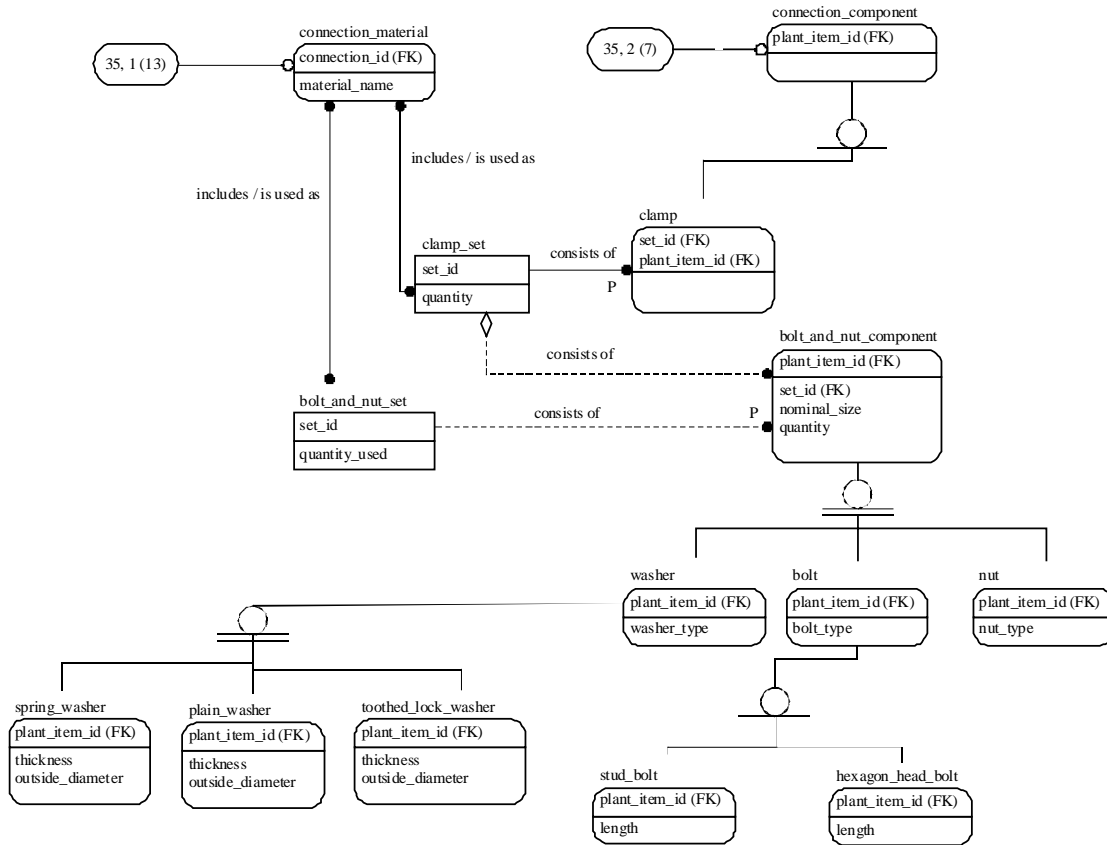


Figure G.36 - ARM diagram 35 of 42

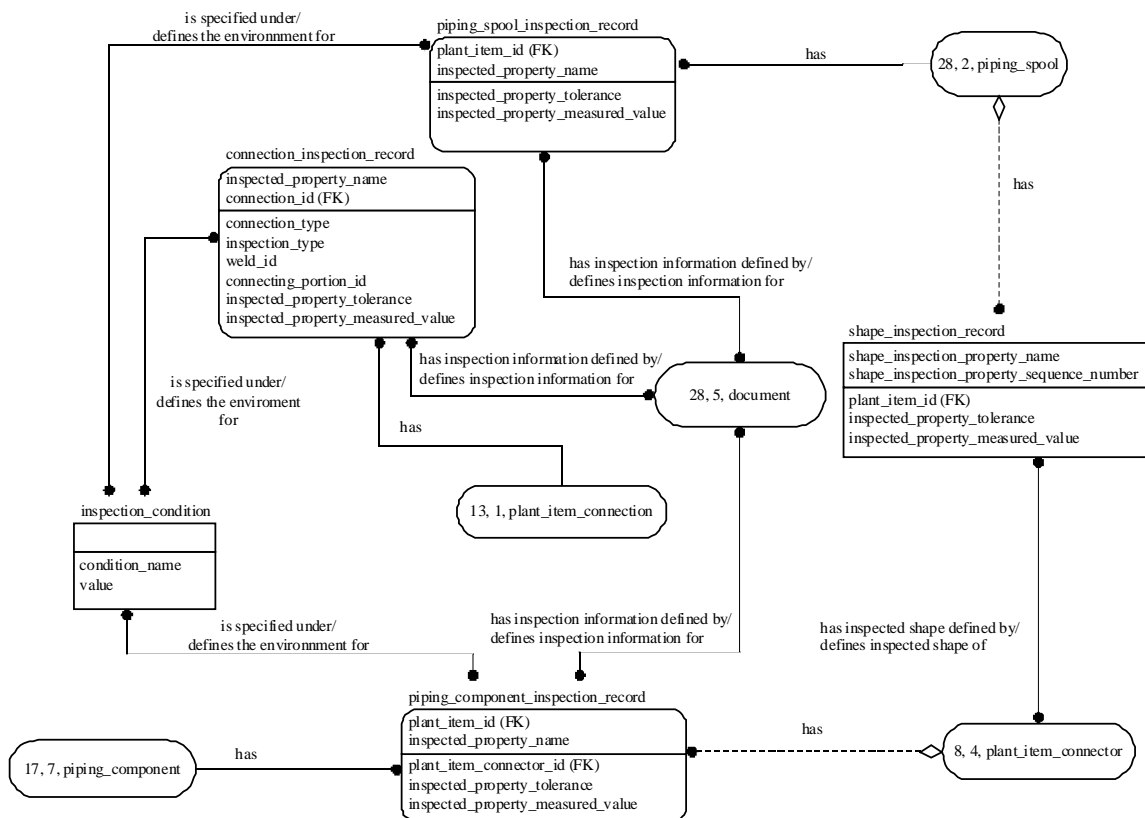


Figure G.37 - ARM diagram 36 of 42

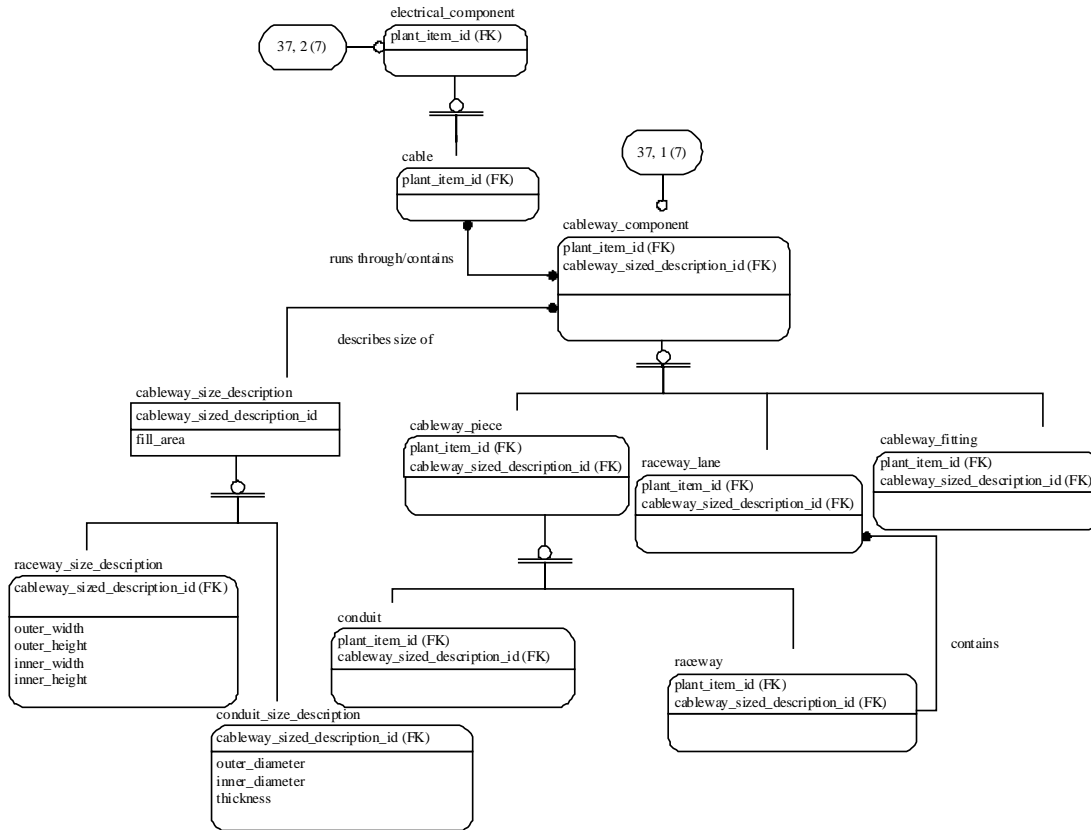


Figure G.38 - ARM diagram 37 of 42

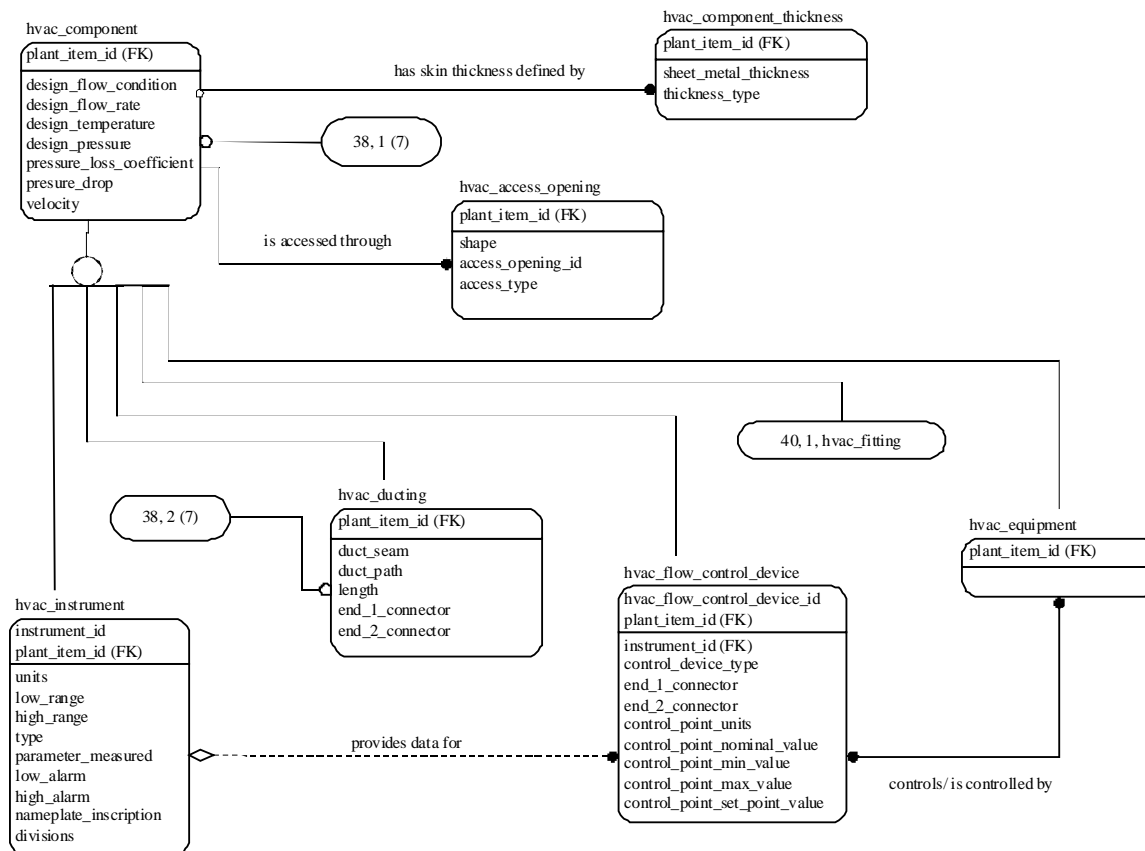


Figure G.39 - ARM diagram 38 of 42

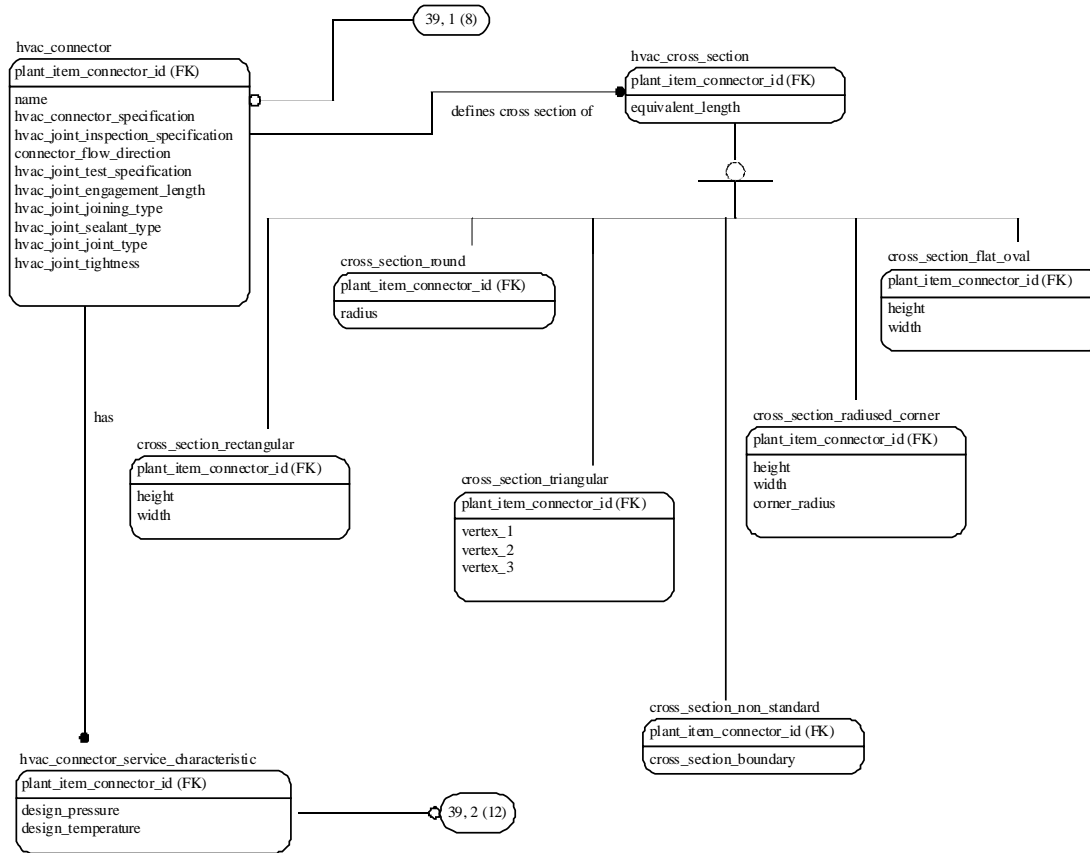


Figure G.40 - ARM diagram 39 of 42

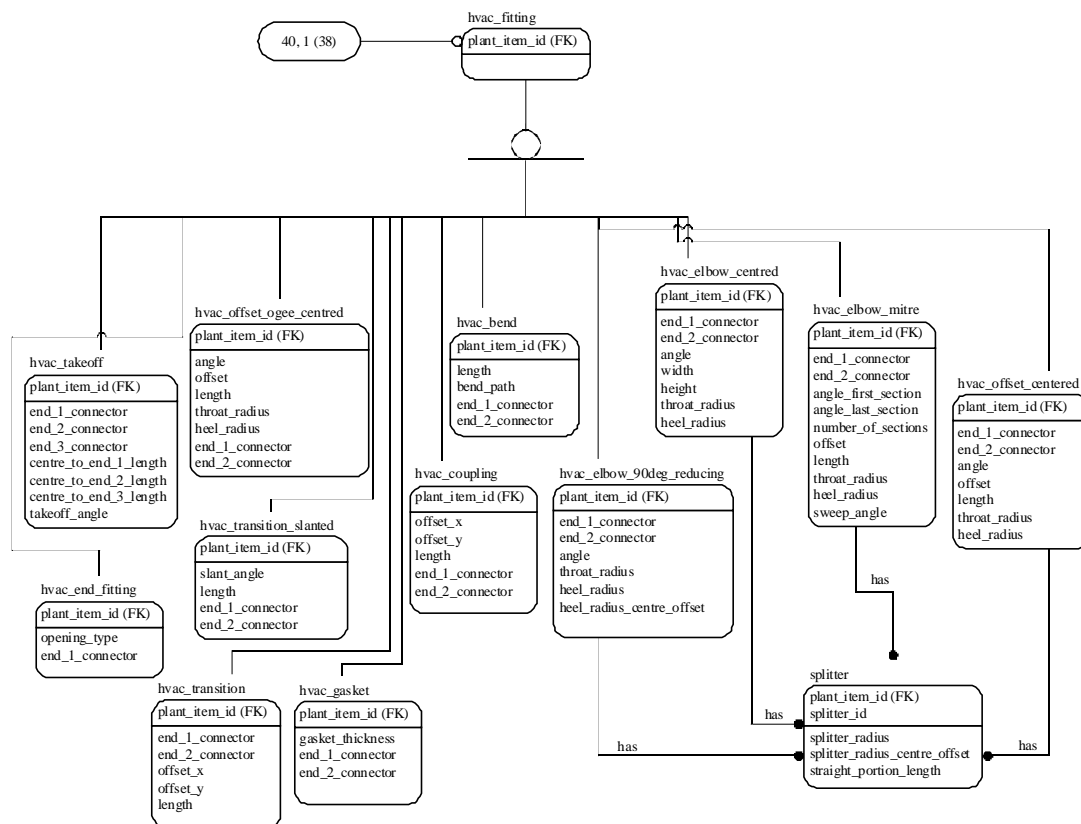
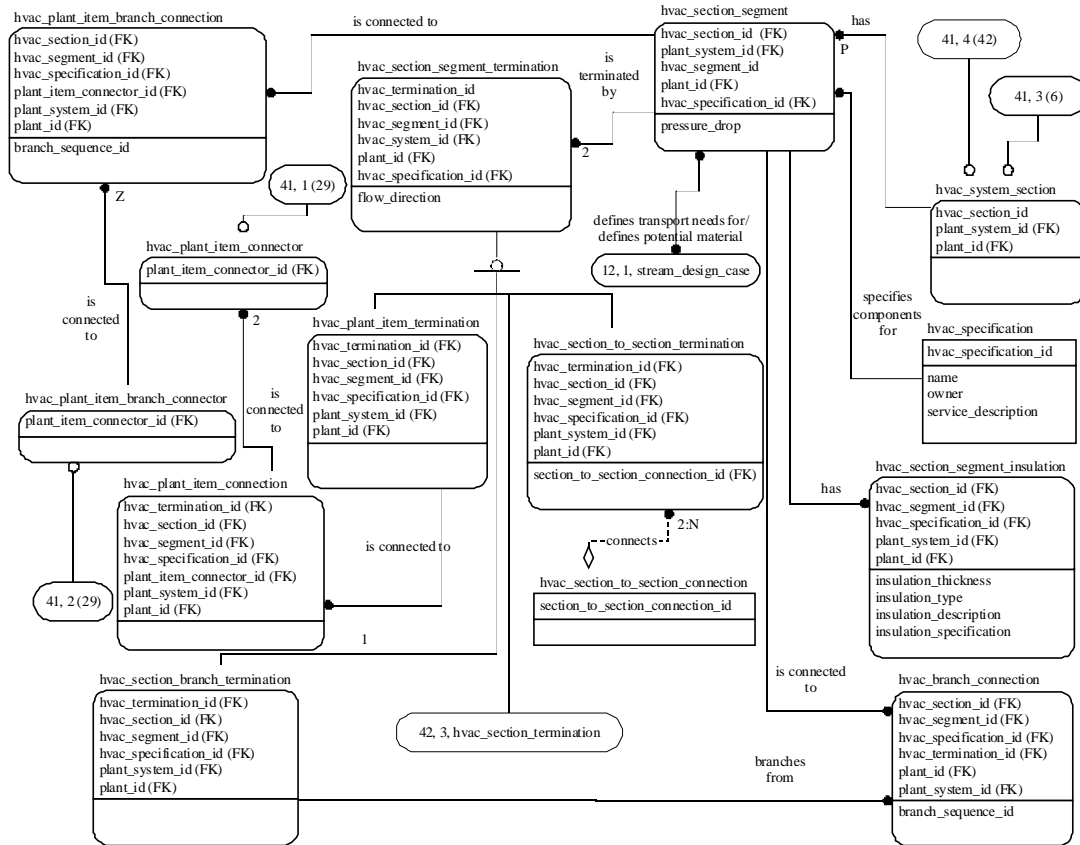


Figure G.41 - ARM diagram 40 of 42



**Figure G.42 - ARM diagram 41 of 42**

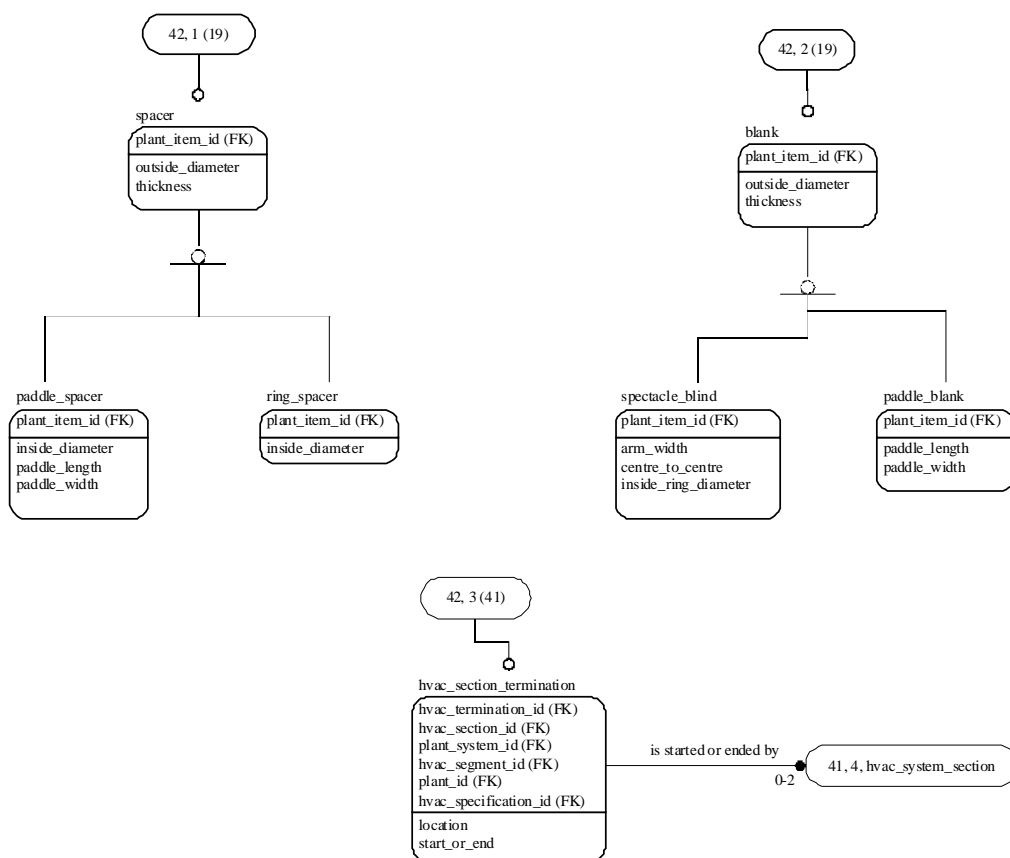


Figure G.43 - ARM diagram 42 of 42

**Annex H**  
(informative)

**AIM EXPRESS-G**

Figures H.1 through H.41 correspond to the AIM EXPRESS expanded listing given in annex A. The figures use the EXPRESS-G graphical notation for the EXPRESS language. EXPRESS-G is defined in annex A of ISO 10303-11.

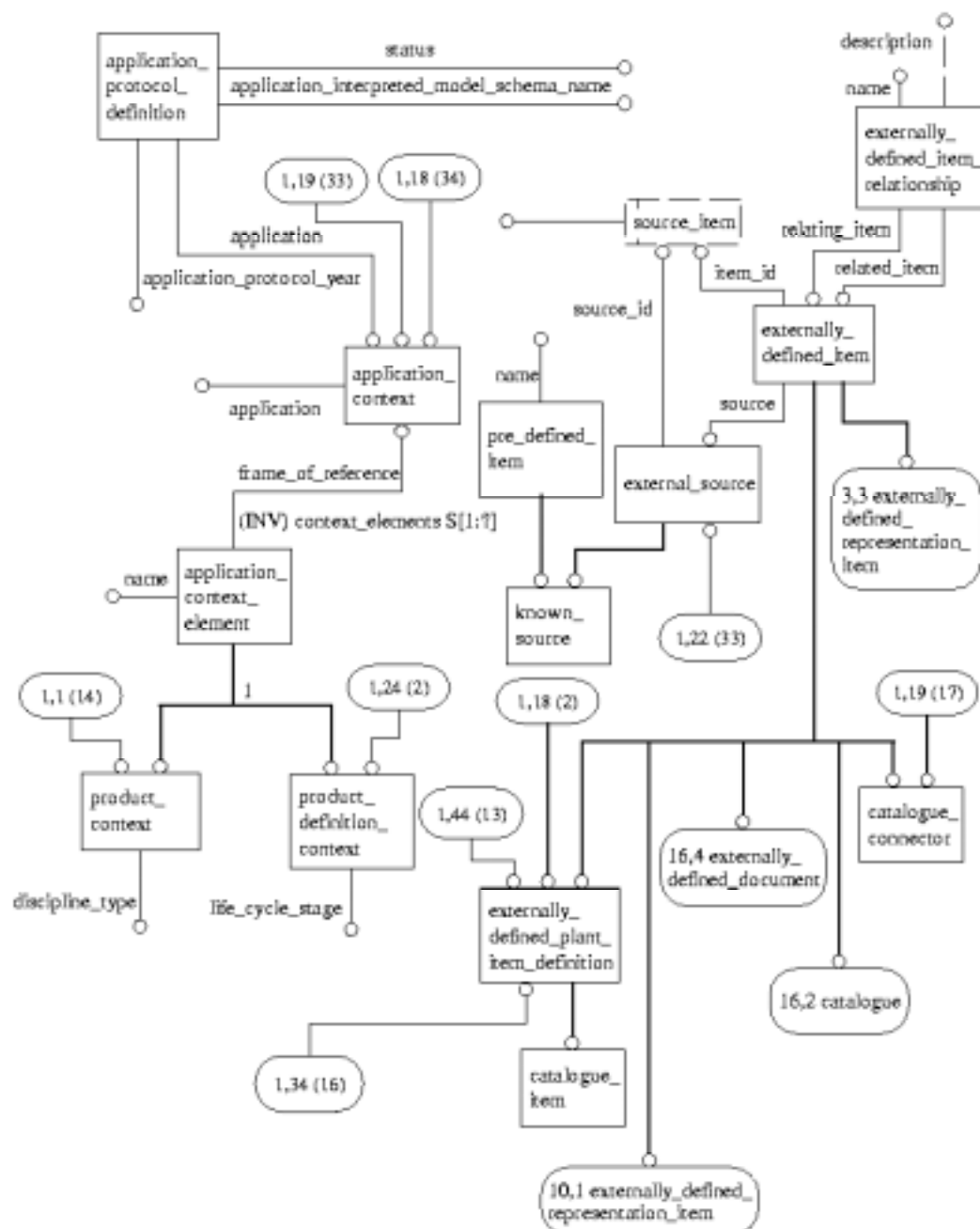
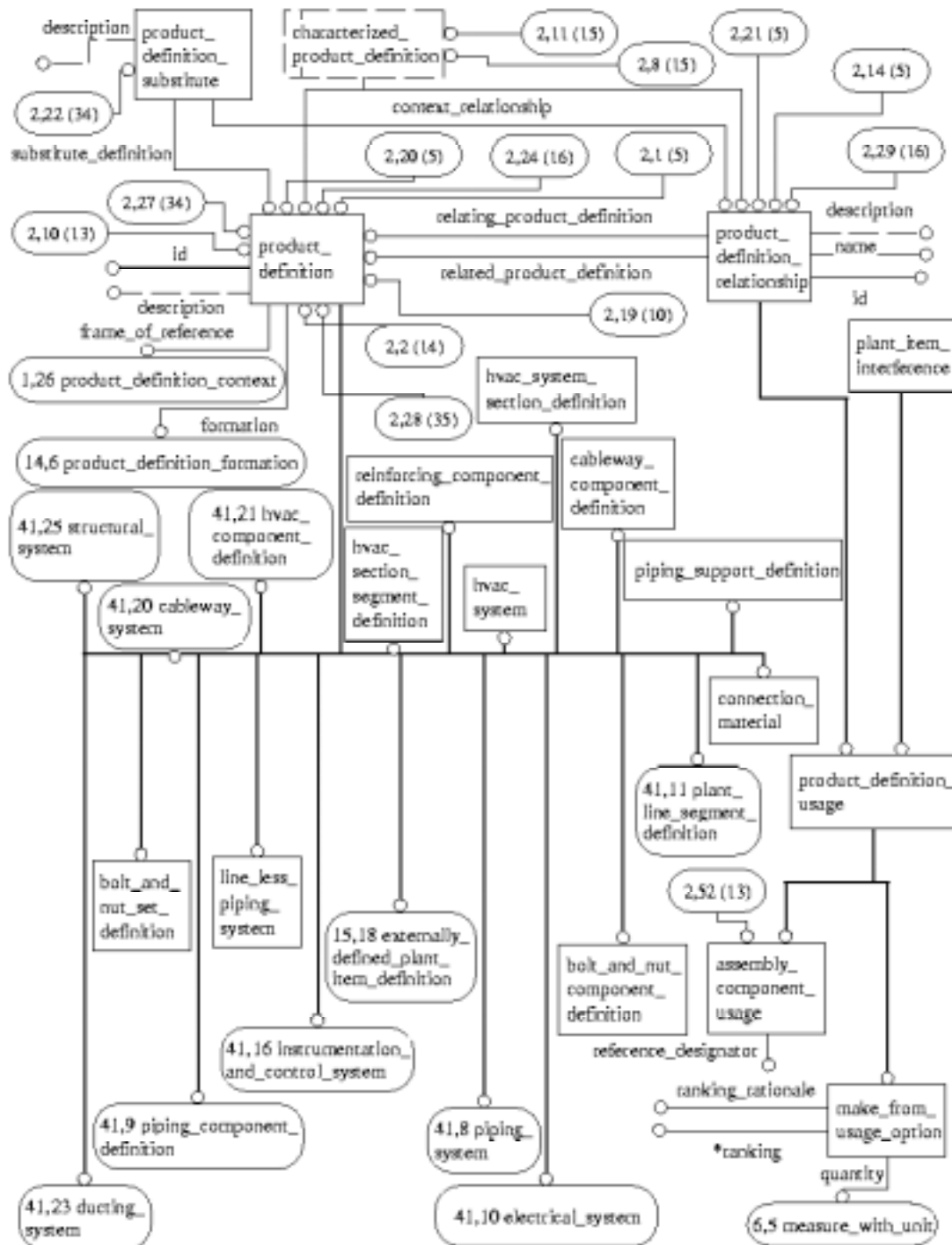


Figure H.1 - AIM EXPRESS-G diagram 1 of 41



**Figure H.2 - AIM EXPRESS-G diagram 2 of 41**

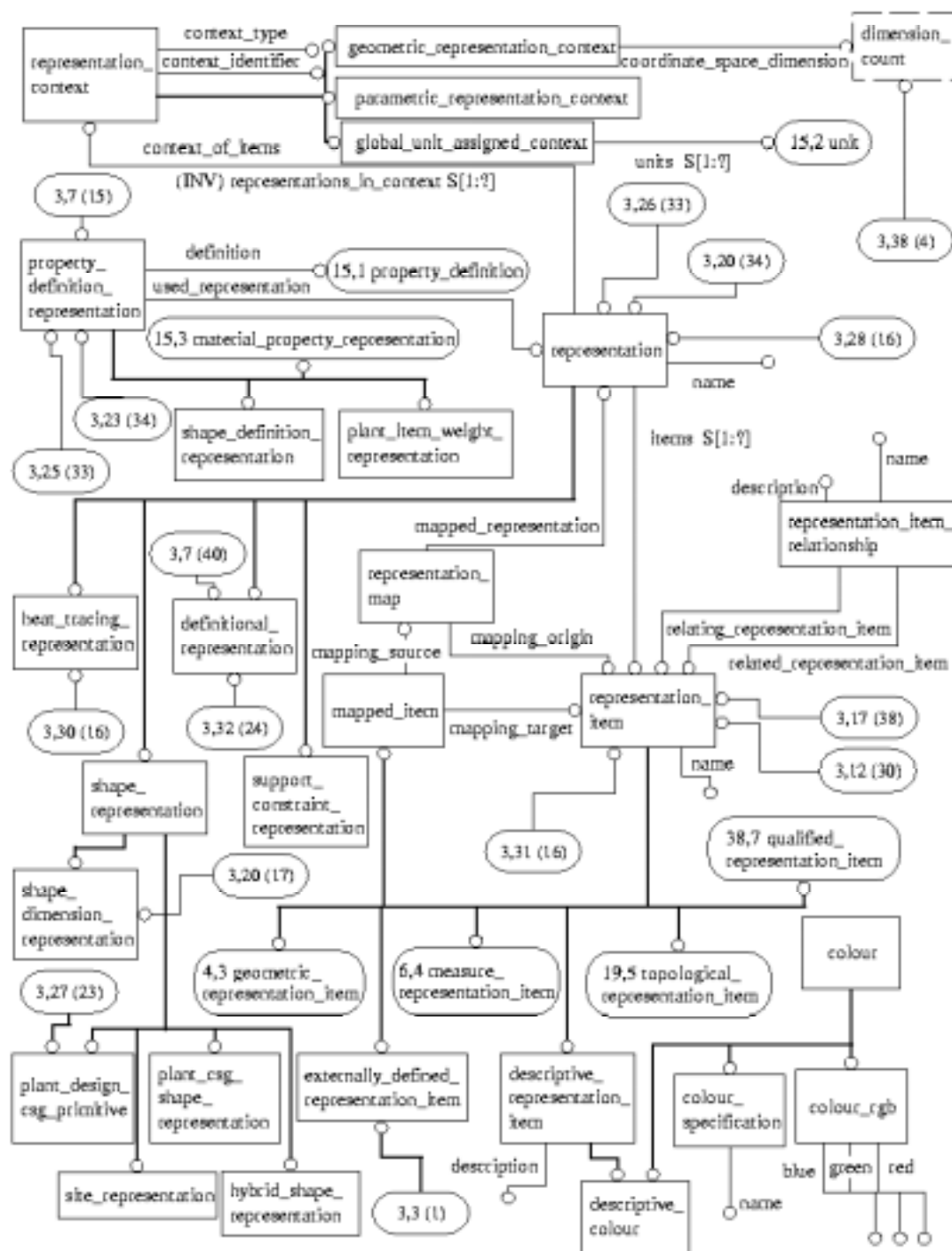


Figure H.3 - AIM EXPRESS-G diagram 3 of 41

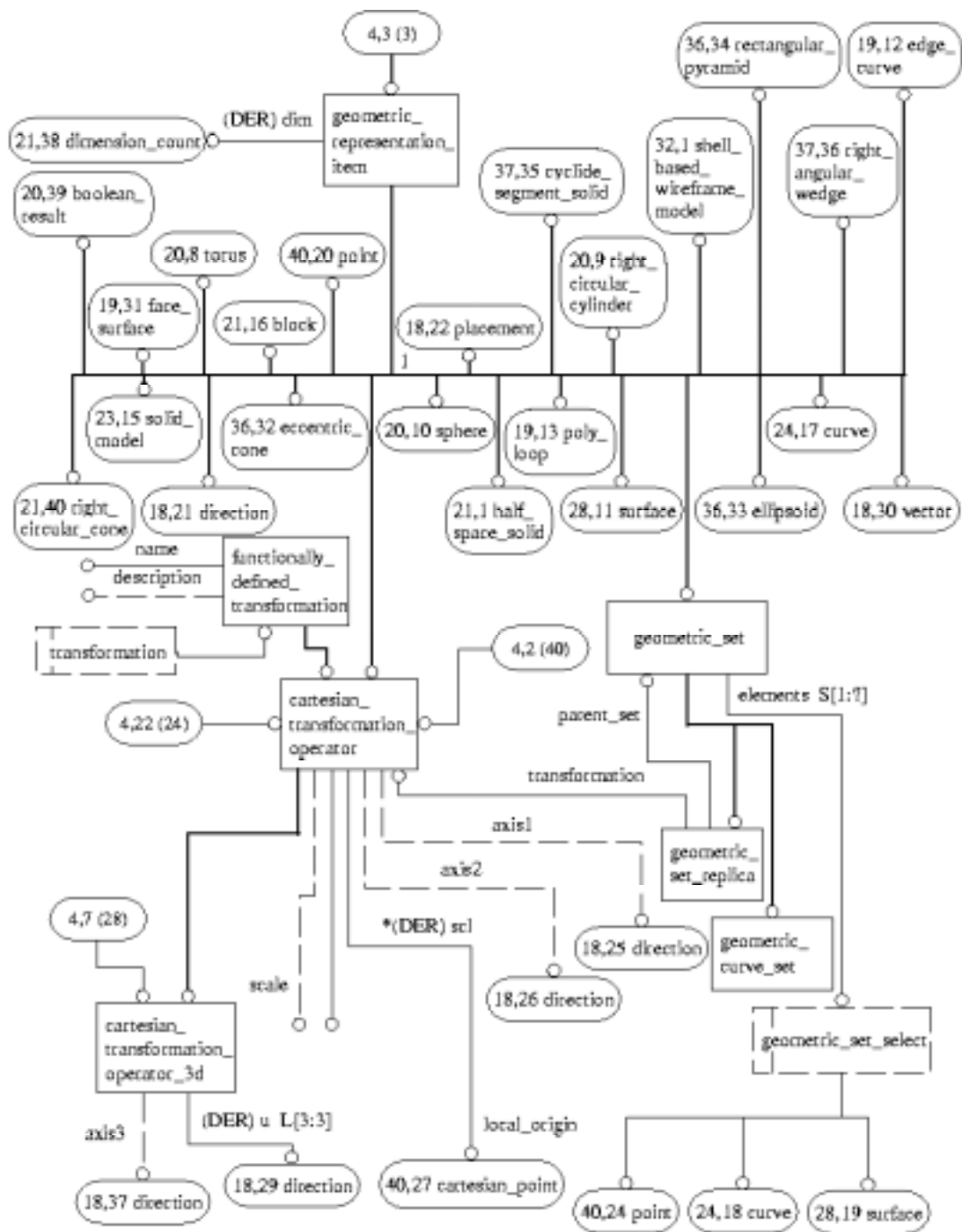


Figure H.4 - AIM EXPRESS-G diagram 4 of 41

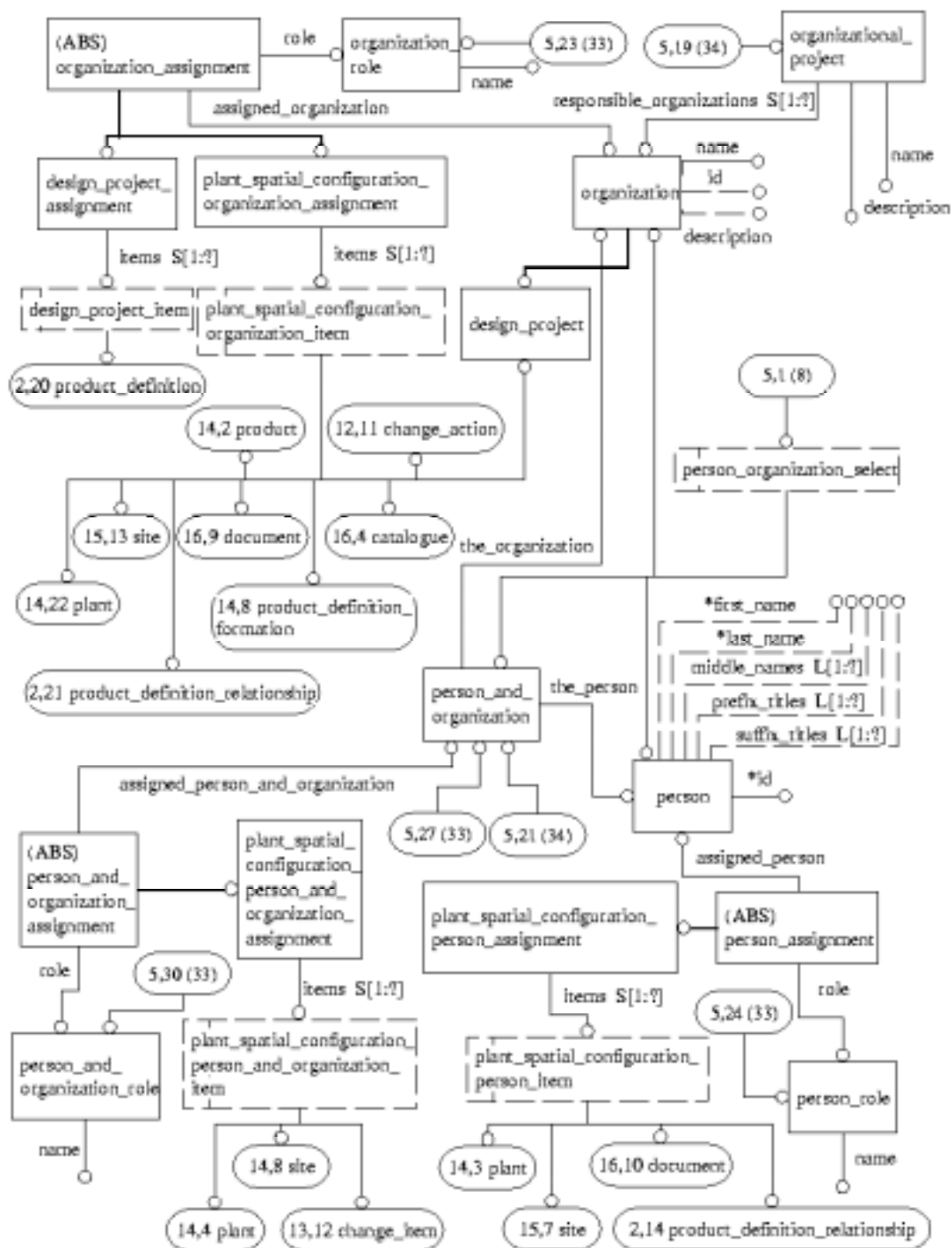


Figure H.5 - AIM EXPRESS-G diagram 5 of 41

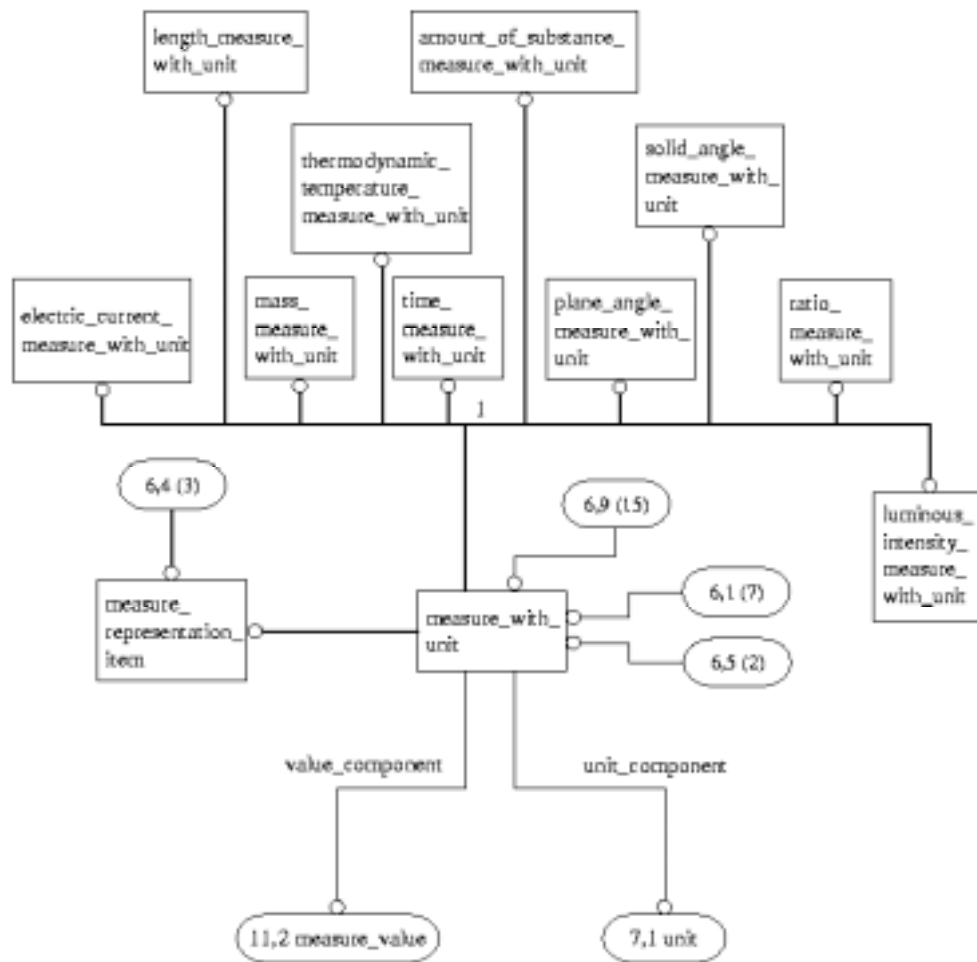


Figure H.6 - AIM EXPRESS-G diagram 6 of 41

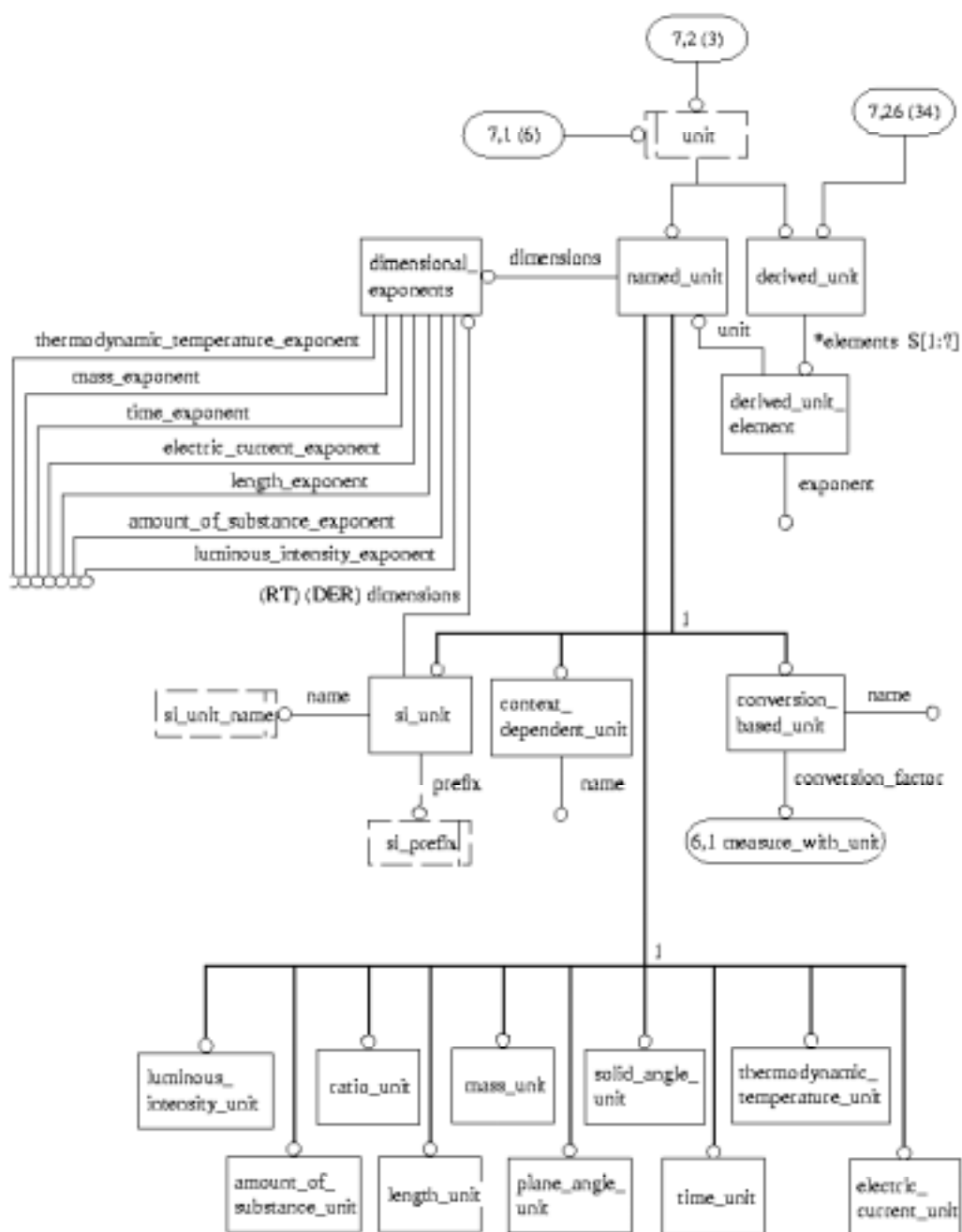


Figure H.7 - AIM EXPRESS-G diagram 7 of 41

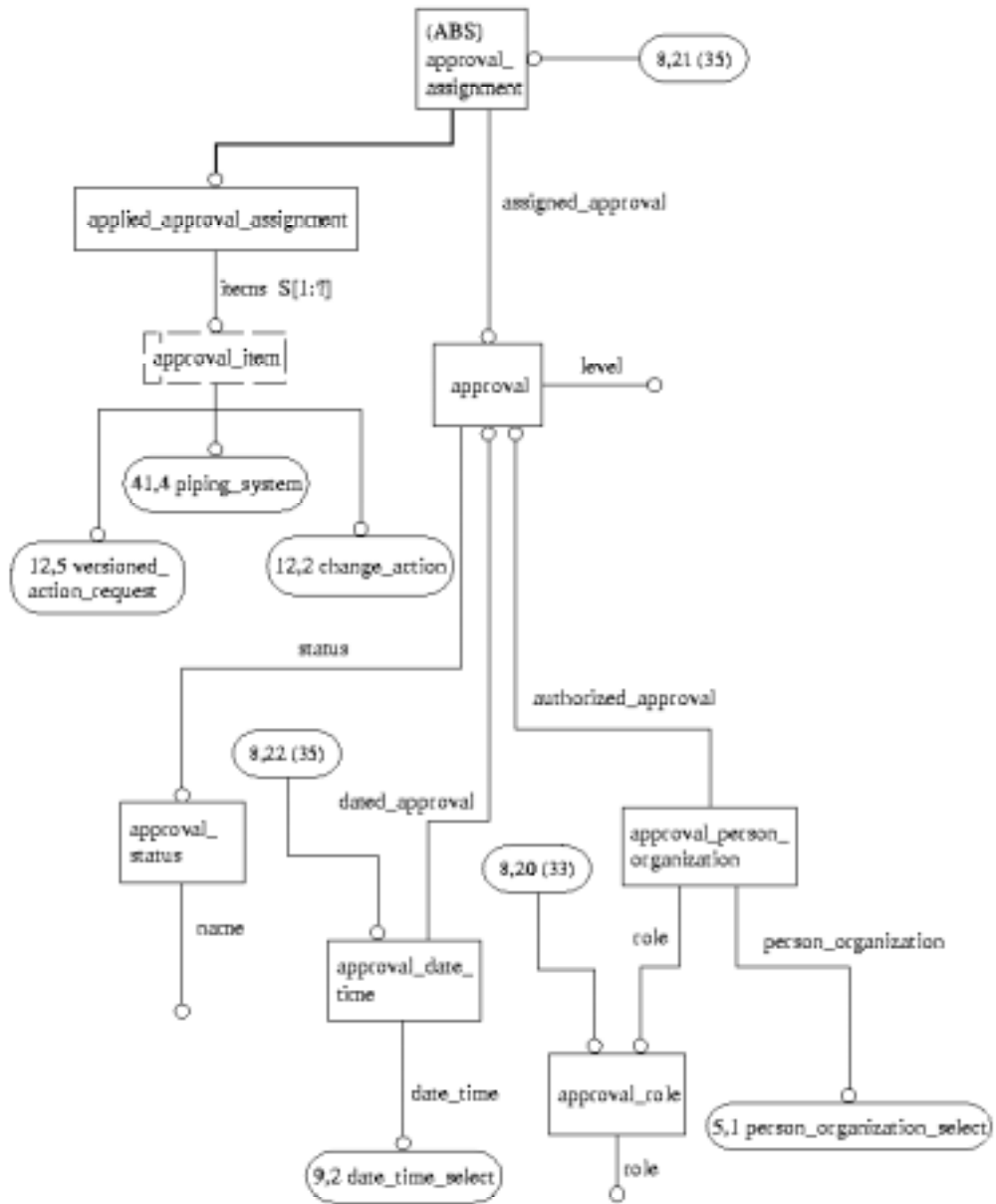


Figure H.8 - AIM EXPRESS-G diagram 8 of 41

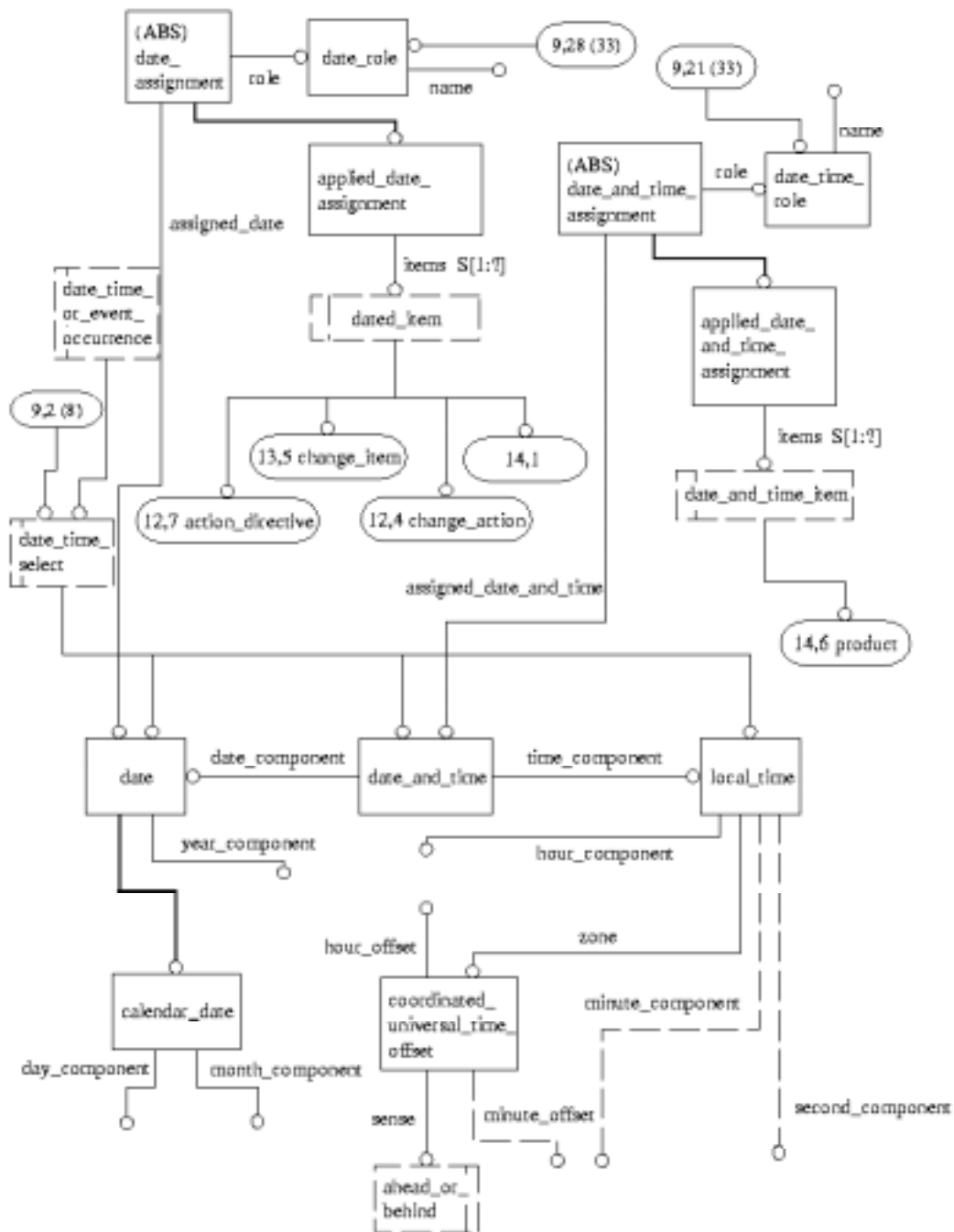


Figure H.9 - AIM EXPRESS-G diagram 9 of 41

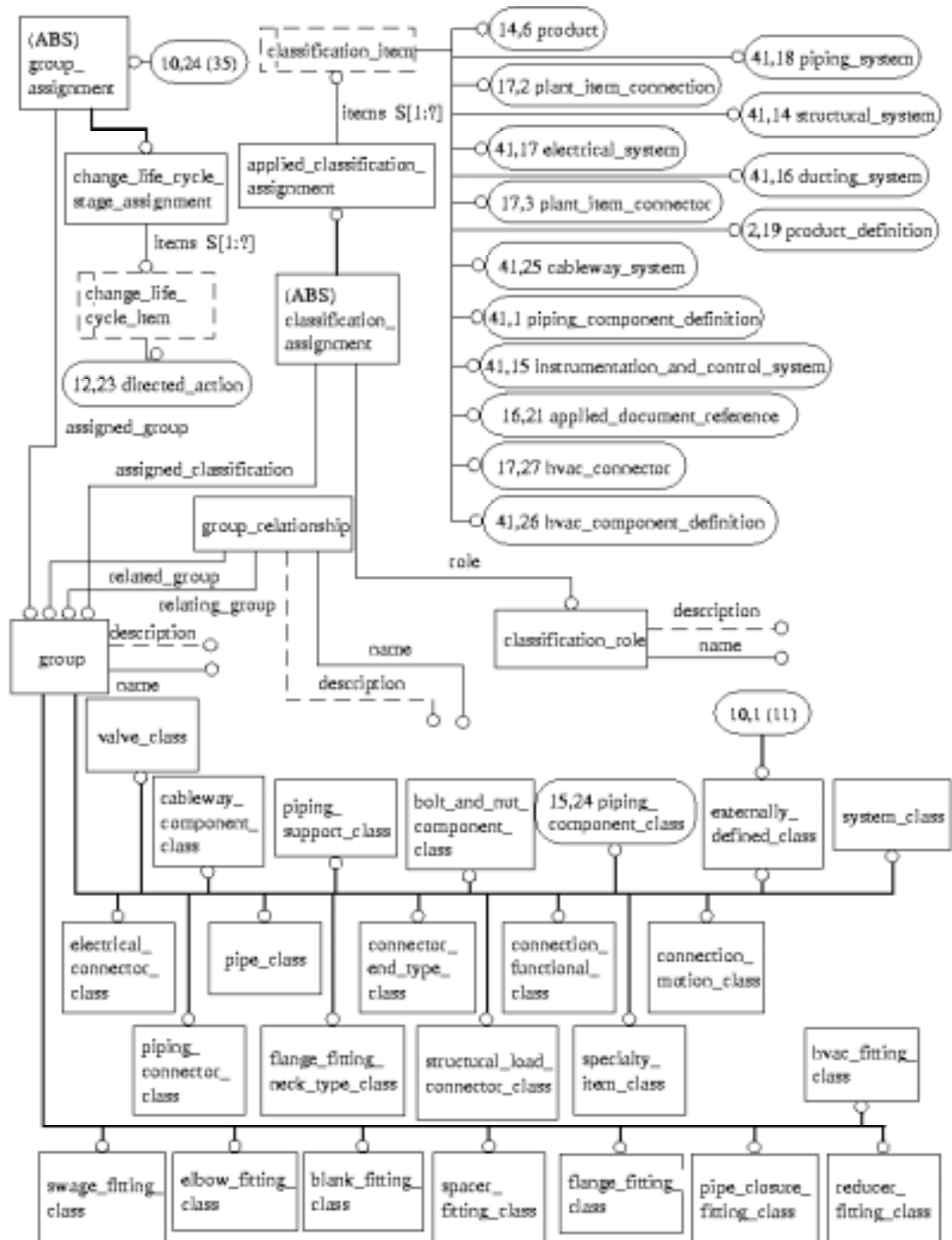
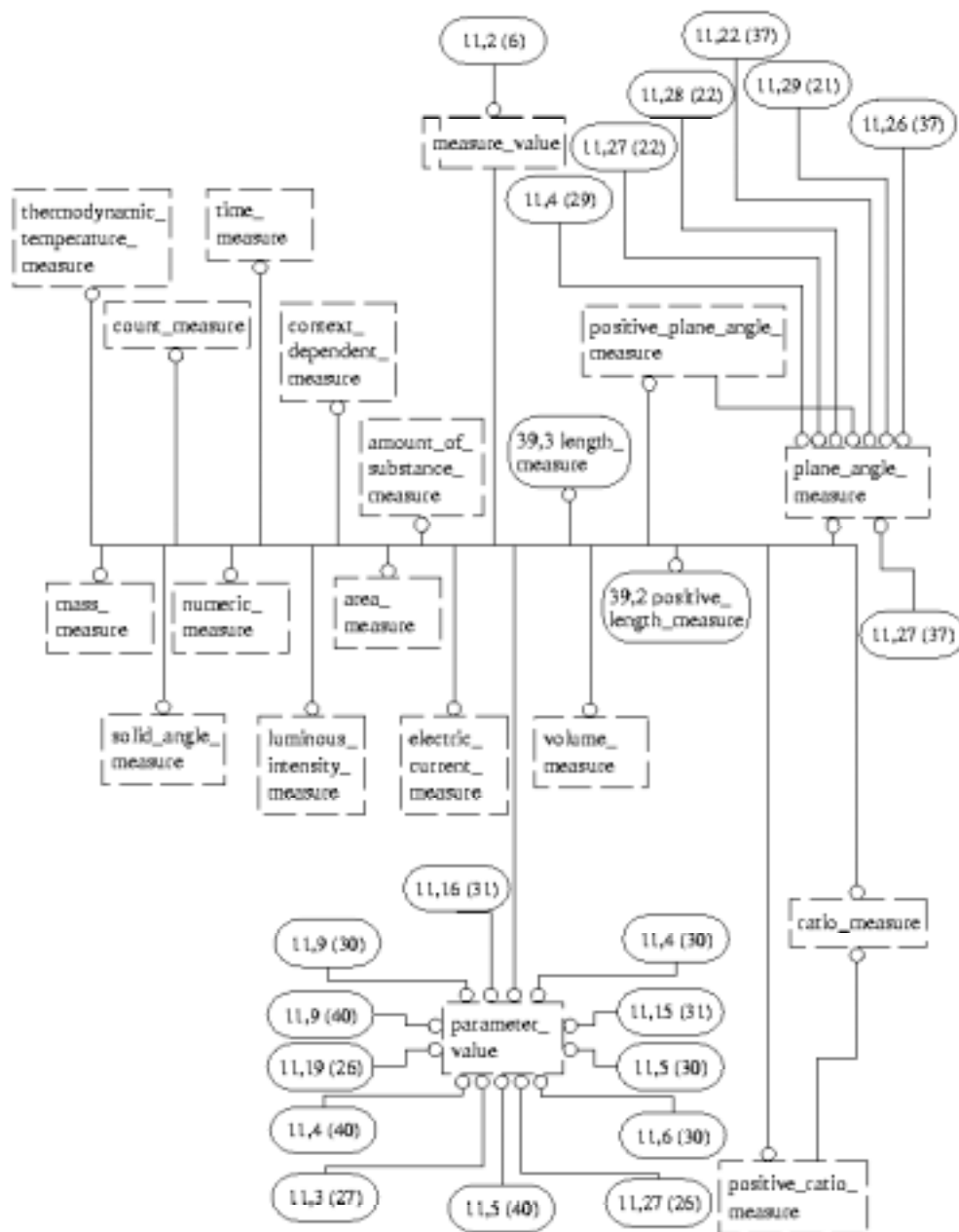


Figure H.10 - AIM EXPRESS-G diagram 10 of 41



**Figure H.11 - AIM EXPRESS-G diagram 11 of 41**

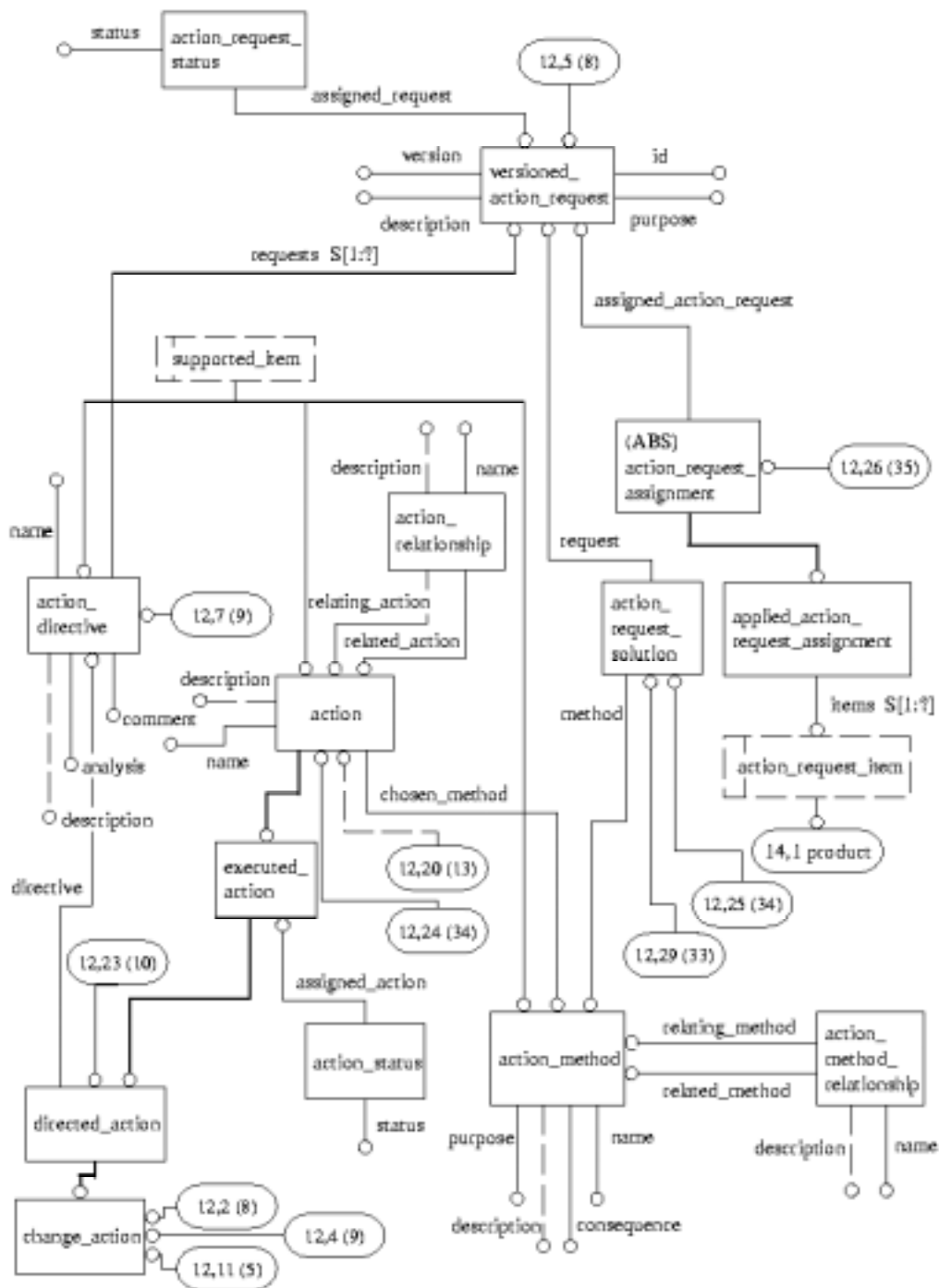
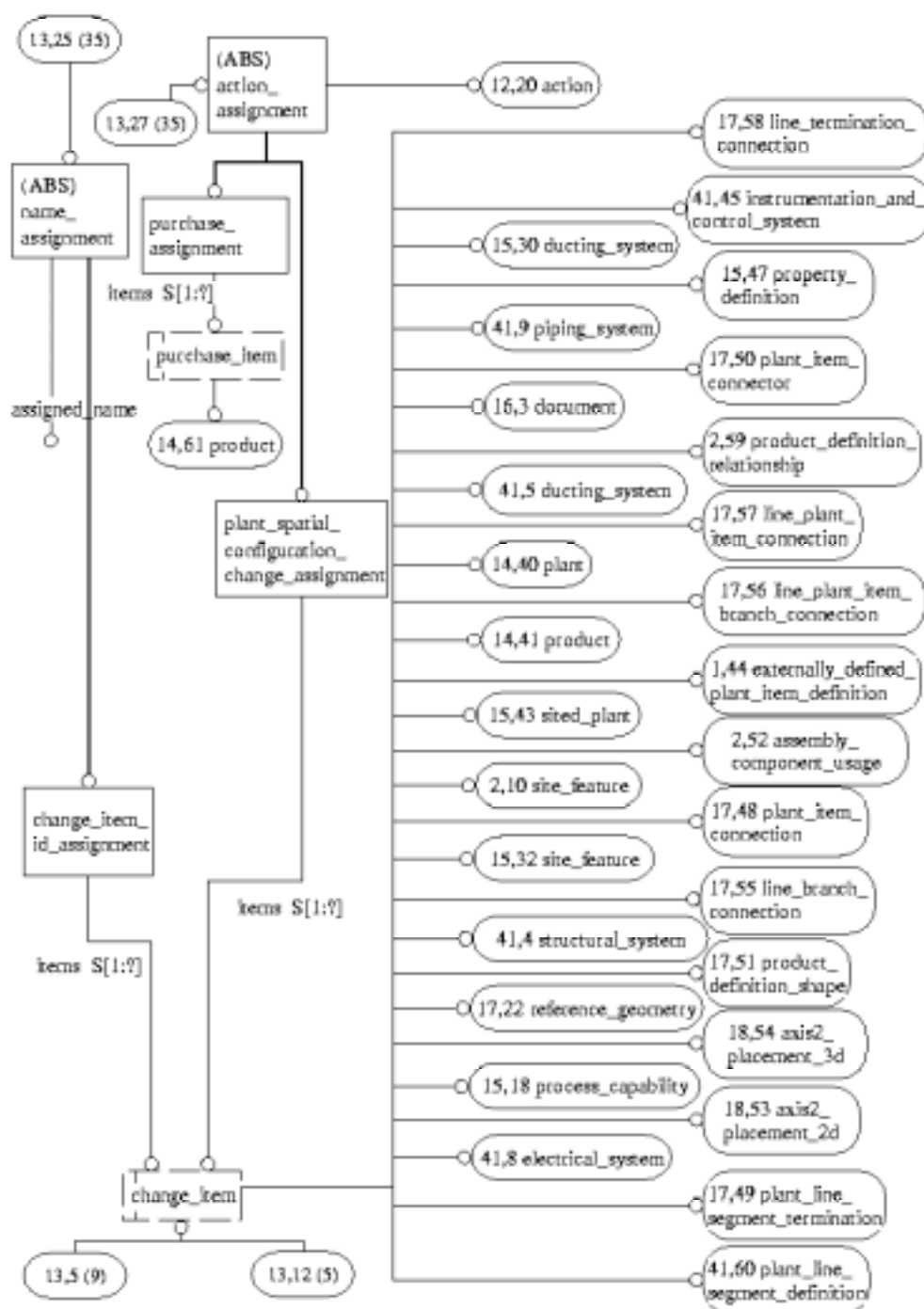


Figure H.12 - AIM EXPRESS-G diagram 12 of 41



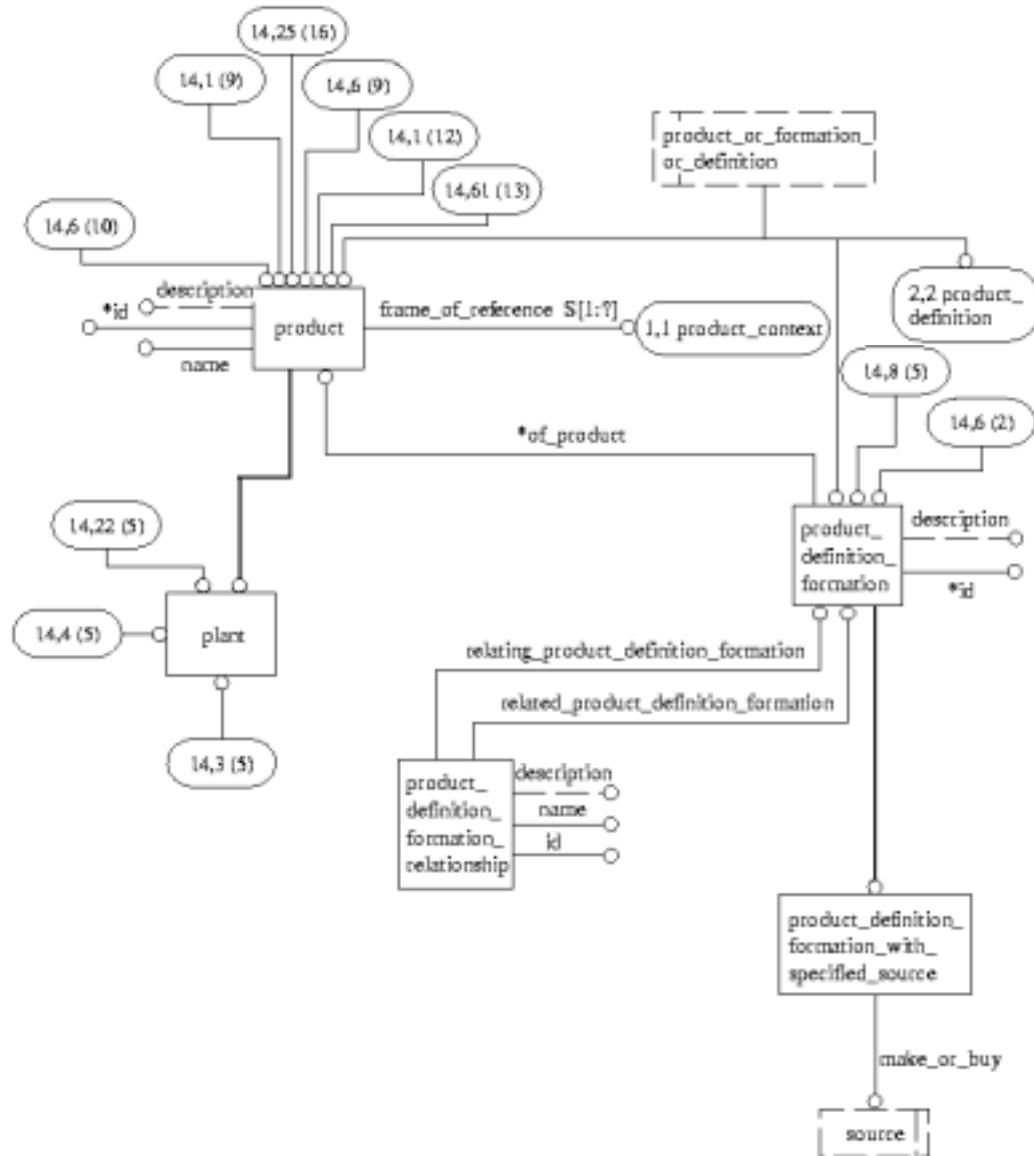


Figure H.14 - AIM EXPRESS-G diagram 14 of 41

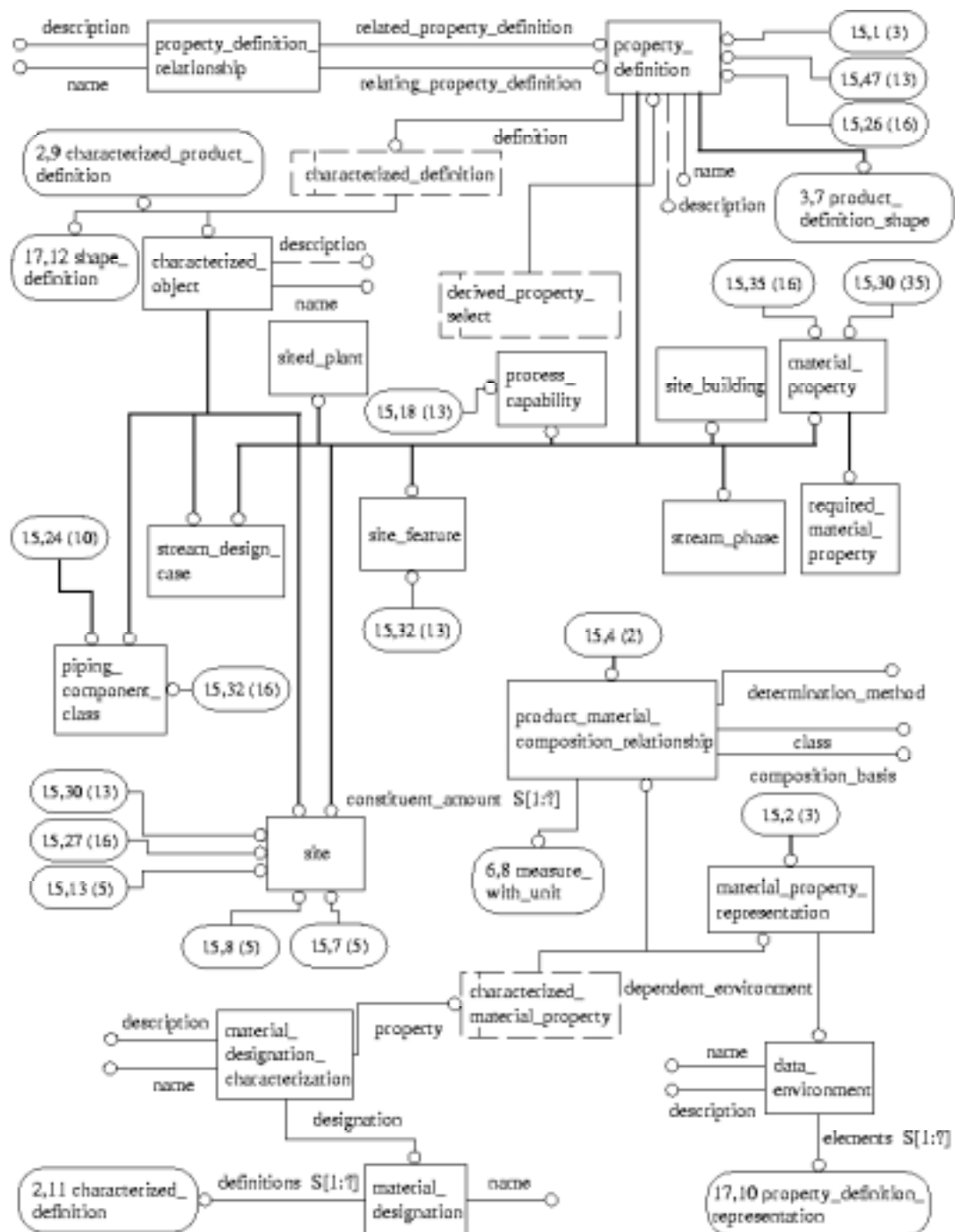


Figure H.15 - AIM EXPRESS-G diagram 15 of 41

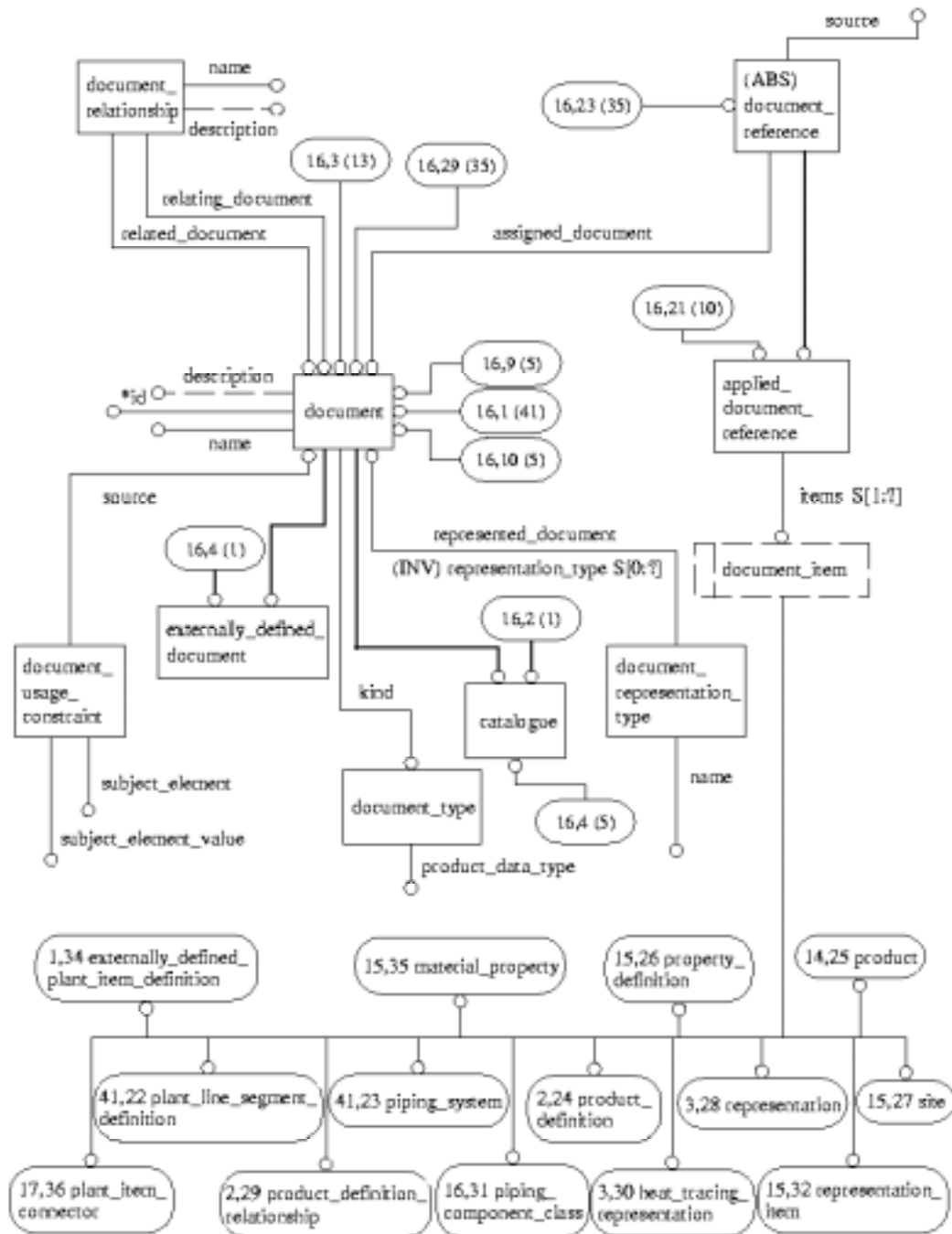


Figure H.16 - AIM EXPRESS-G diagram 16 of 41



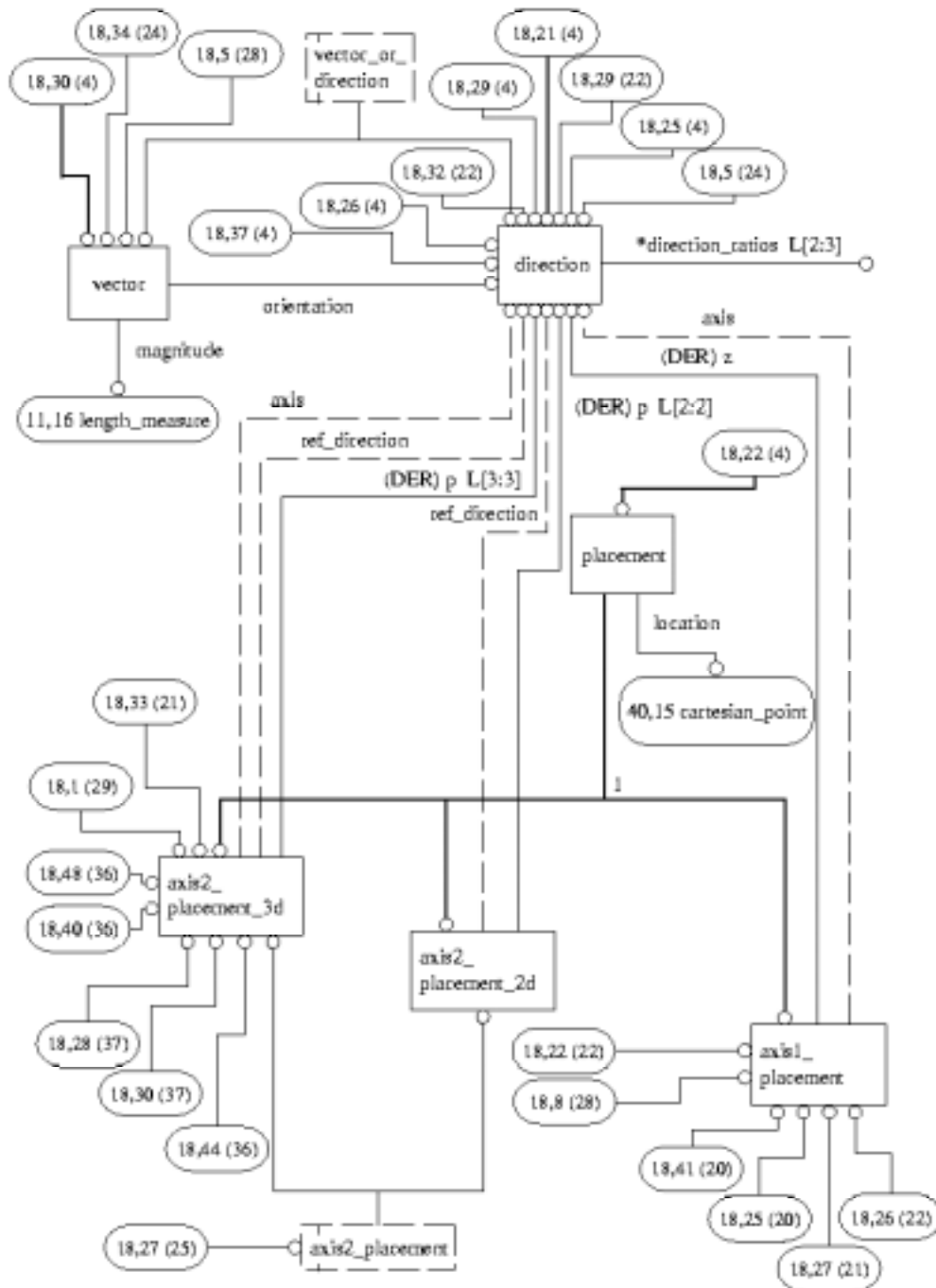


Figure H.18 - AIM EXPRESS-G diagram 18 of 41





Figure H.20 - AIM EXPRESS-G diagram 20 of 41

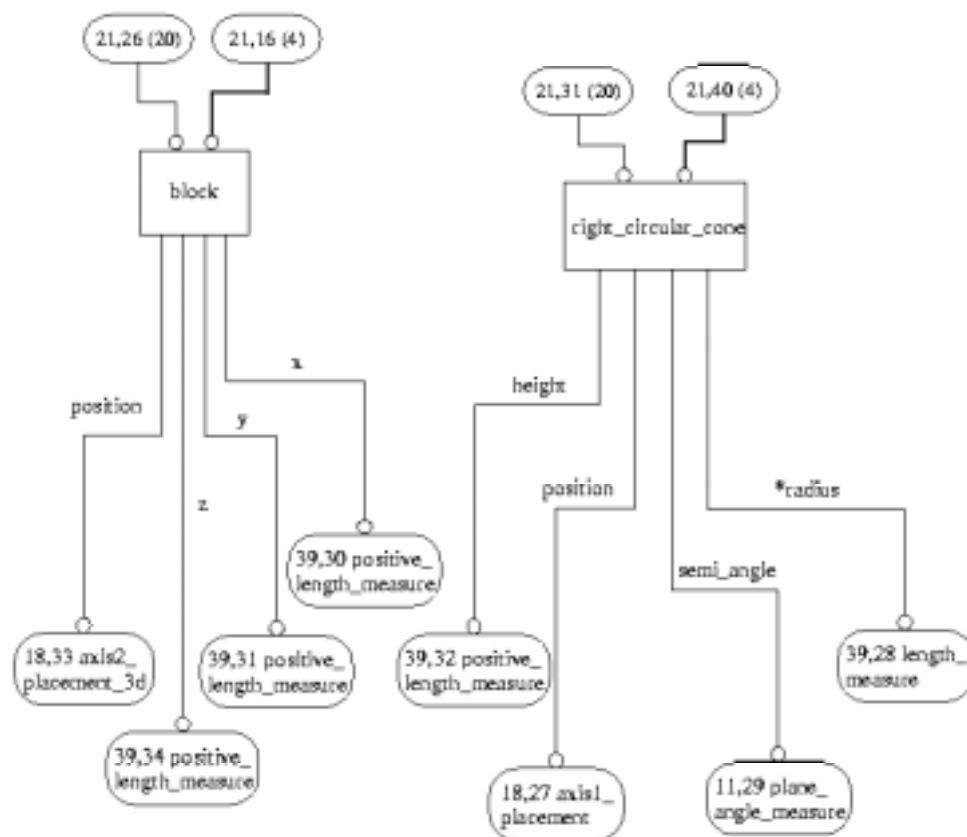


Figure H.21 - AIM EXPRESS-G diagram 21 of 41

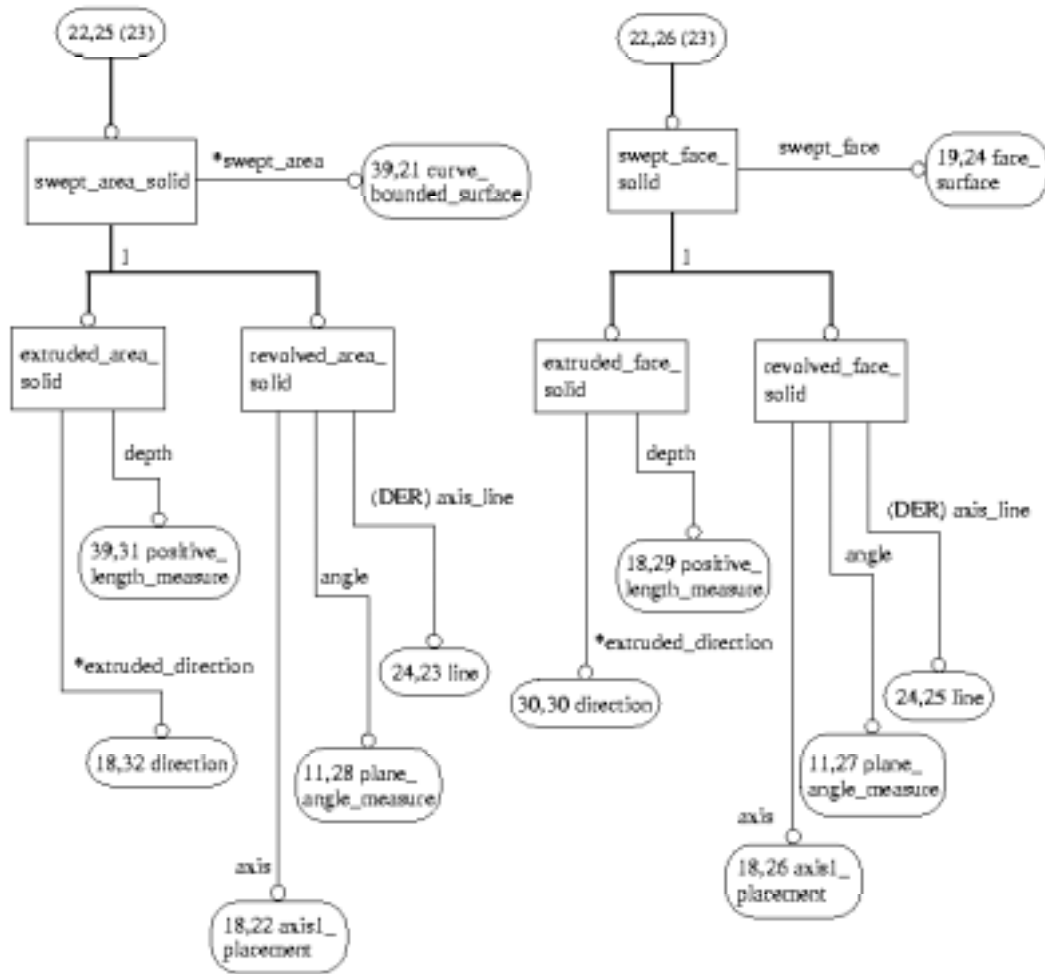


Figure H.22 - AIM EXPRESS-G diagram 22 of 41

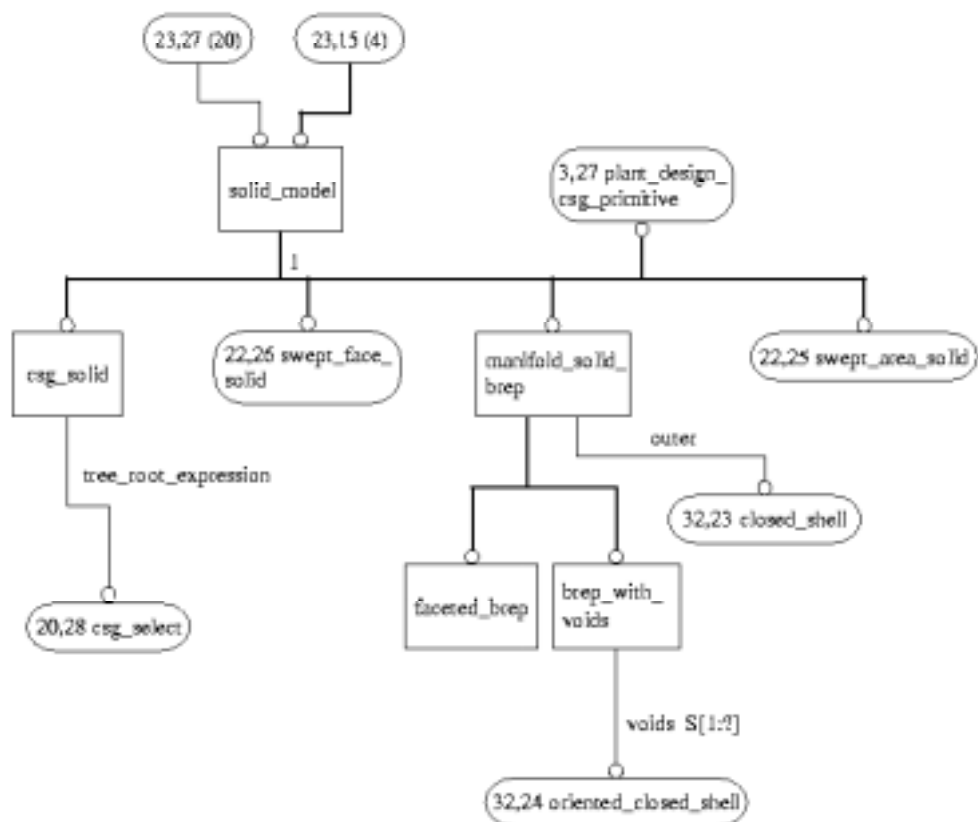


Figure H.23 - AIM EXPRESS-G diagram 23 of 41

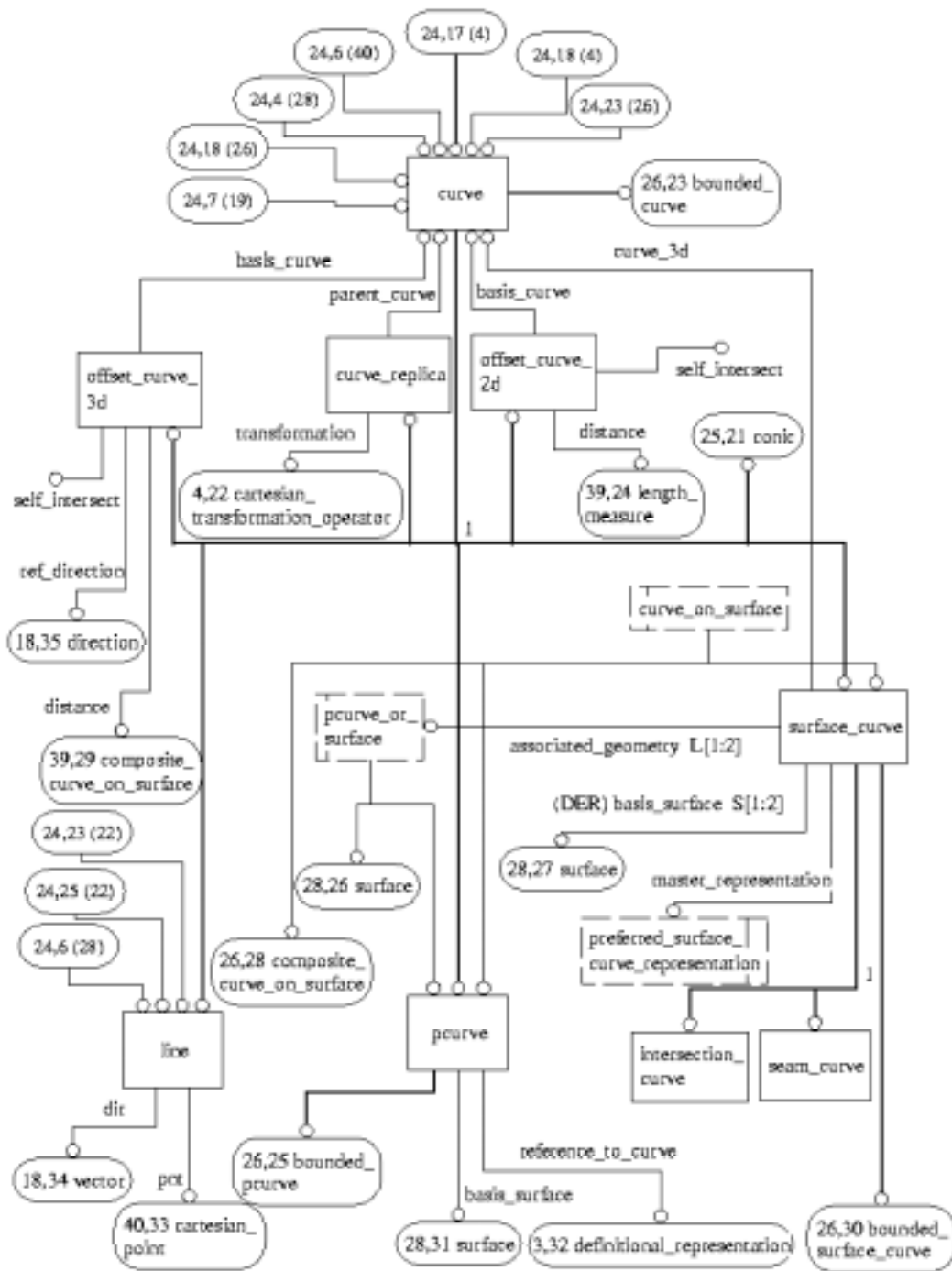


Figure H.24 - AIM EXPRESS-G diagram 24 of 41



Figure H.25 - AIM EXPRESS-G diagram 25 of 41

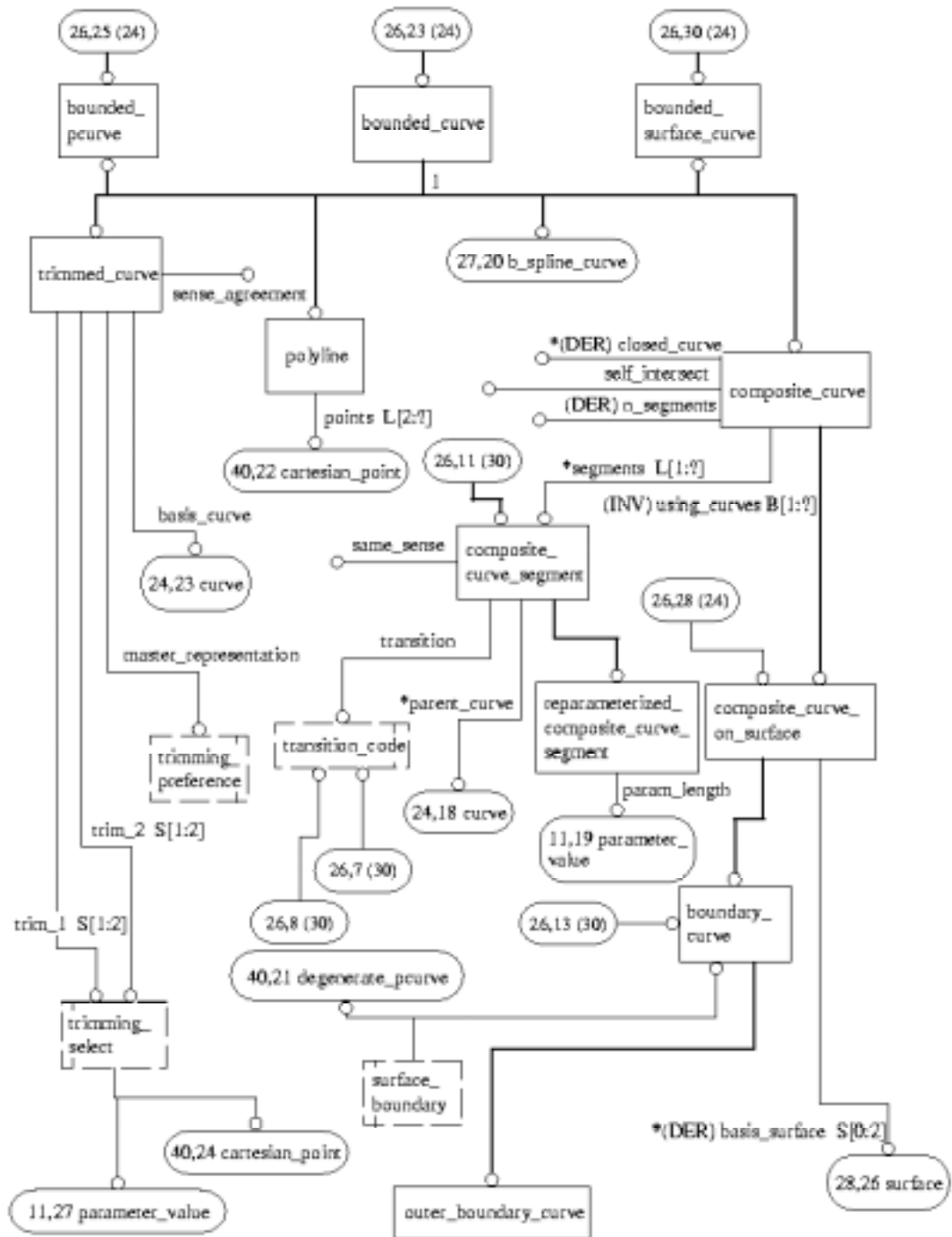


Figure H.26 - AIM EXPRESS-G diagram 26 of 41

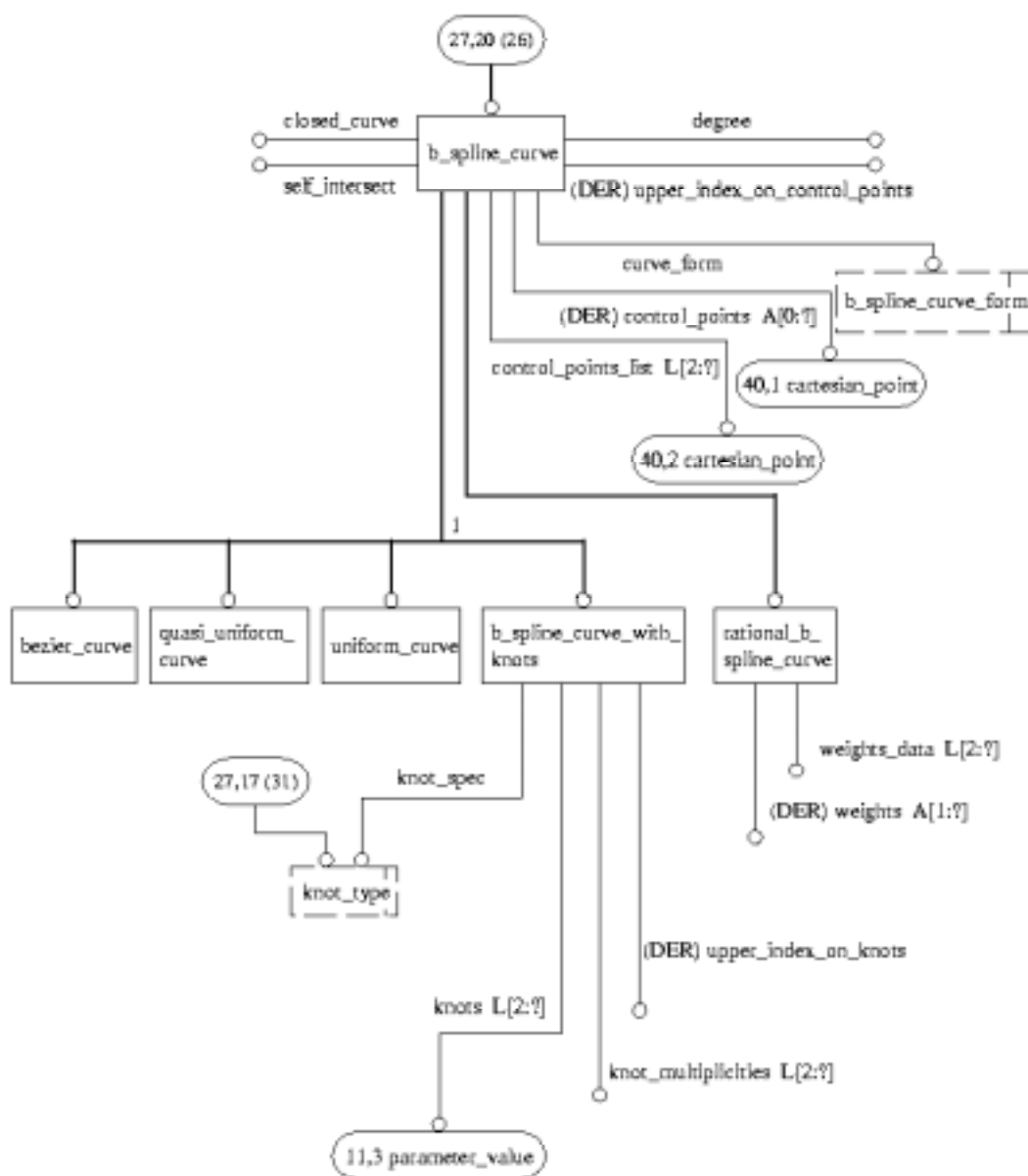


Figure H.27 - AIM EXPRESS-G diagram 27 of 41

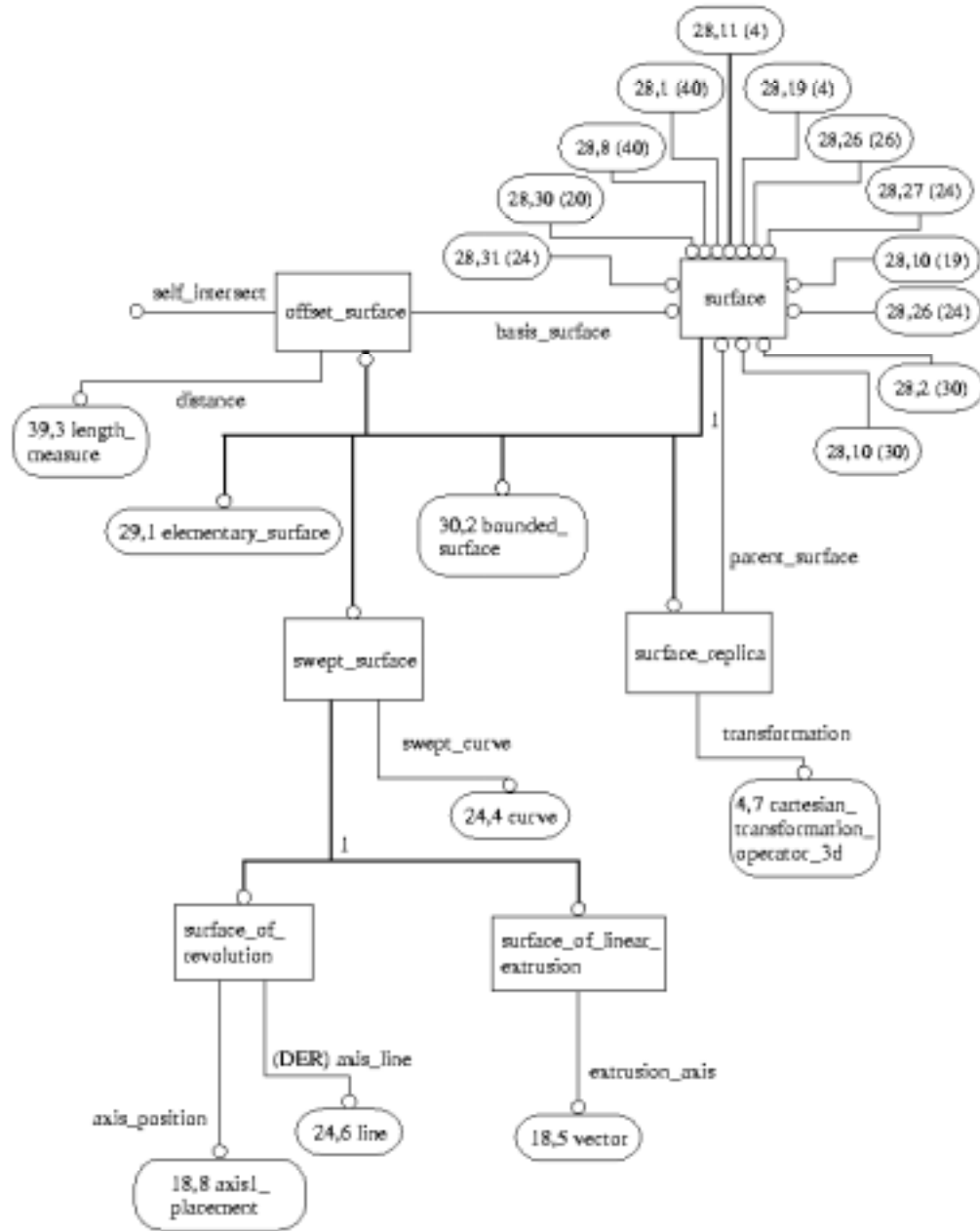


Figure H.28 - AIM EXPRESS-G diagram 28 of 41



Figure H.29 - AIM EXPRESS-G diagram 29 of 41



Figure H.30 - AIM EXPRESS-G diagram 30 of 41

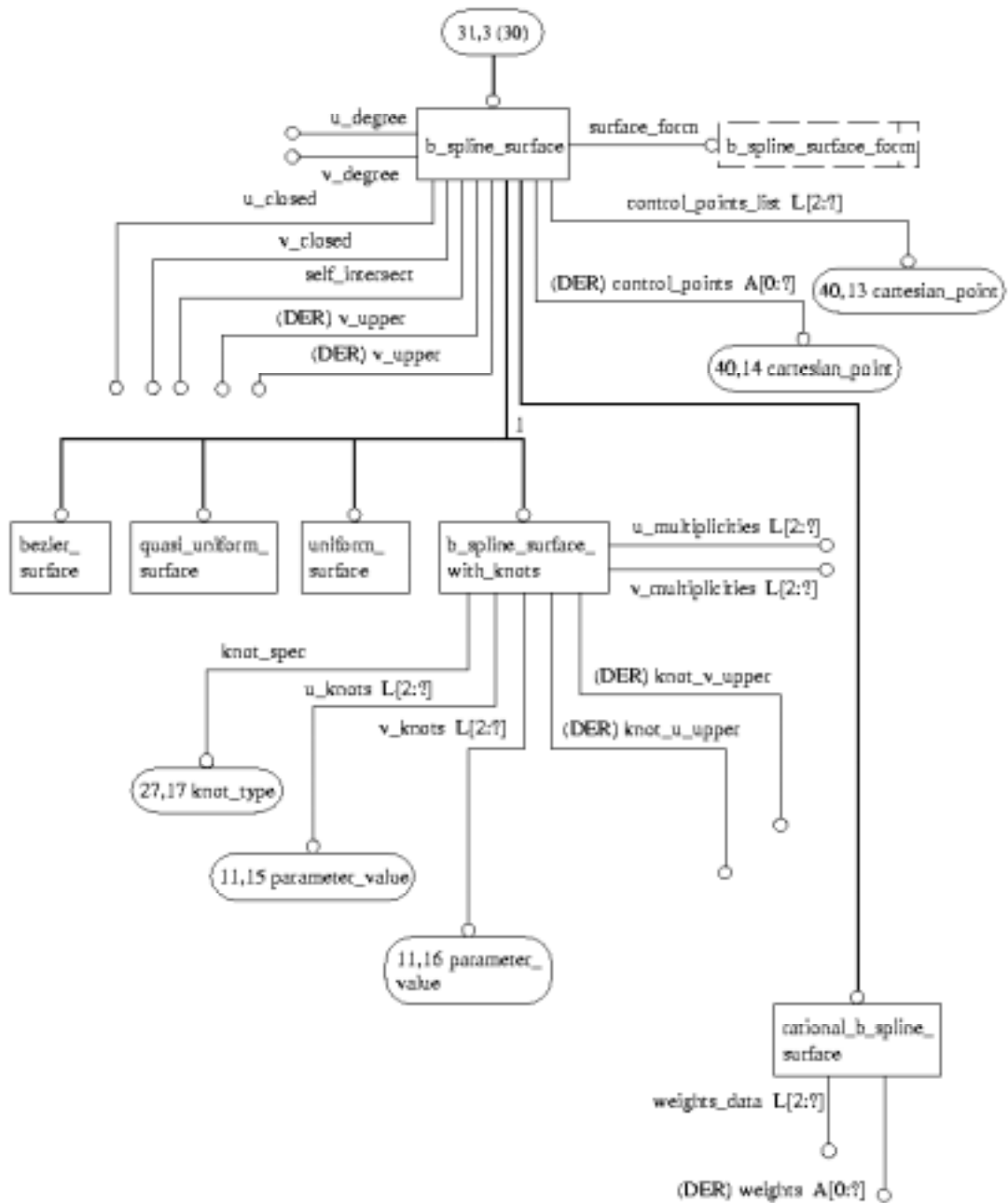


Figure H.31 - AIM EXPRESS-G diagram 31 of 41

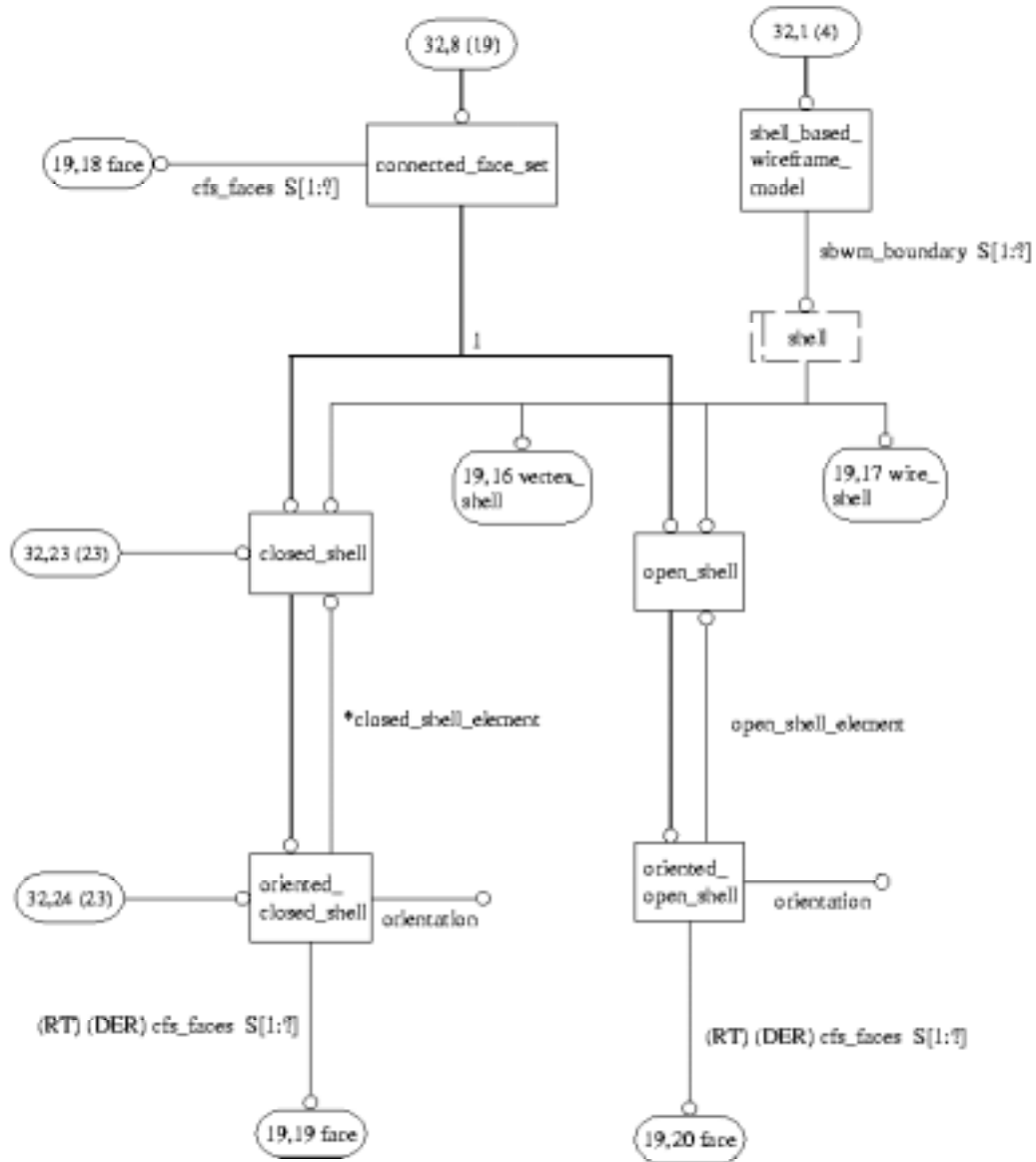


Figure H.32 - AIM EXPRESS-G diagram 32 of 41

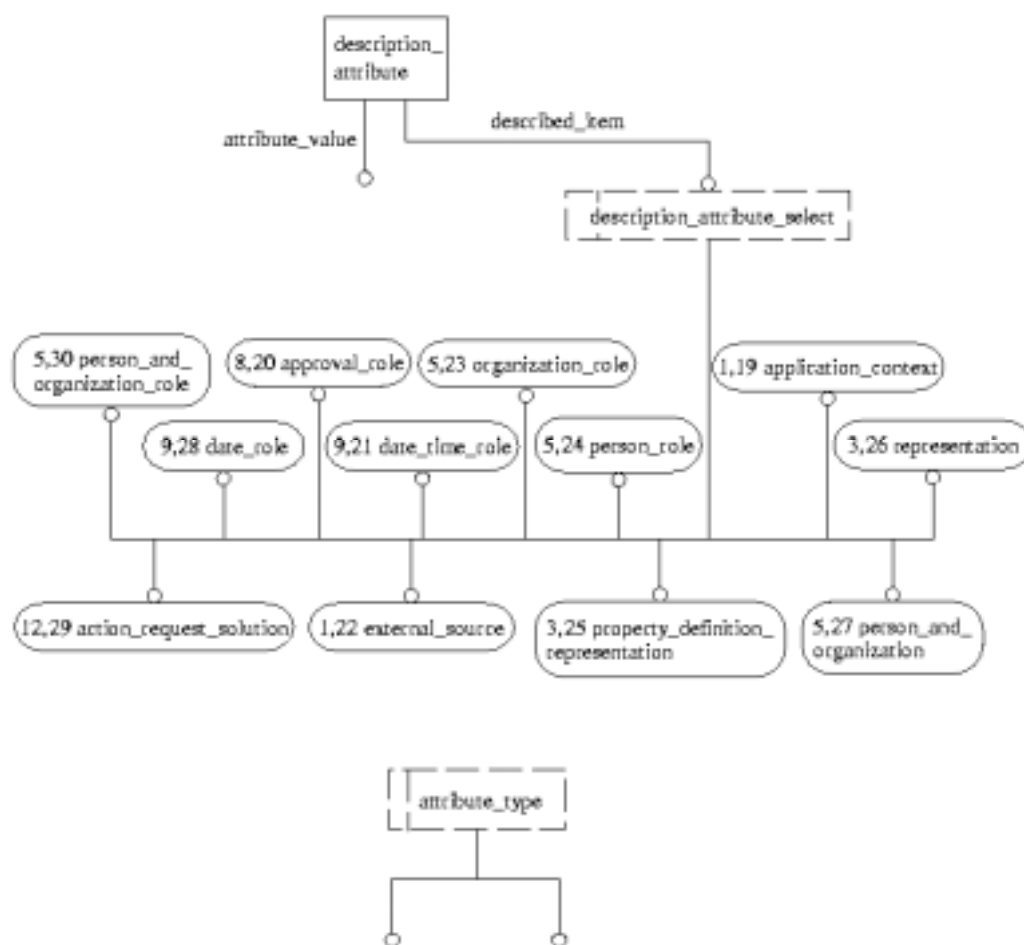


Figure H.33 - AIM EXPRESS-G diagram 33 of 41



Figure H.34 - AIM EXPRESS-G diagram 34 of 41

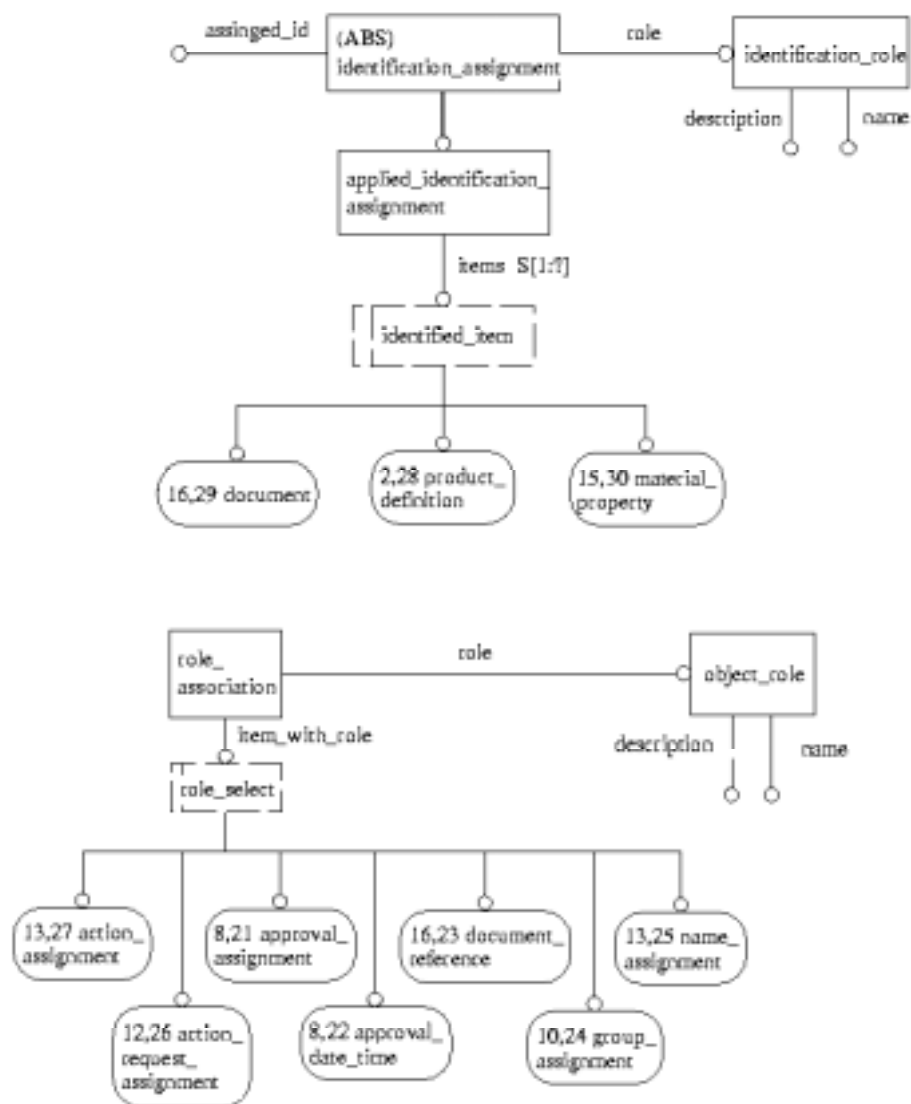


Figure H.35 - AIM EXPRESS-G diagram 35 of 41

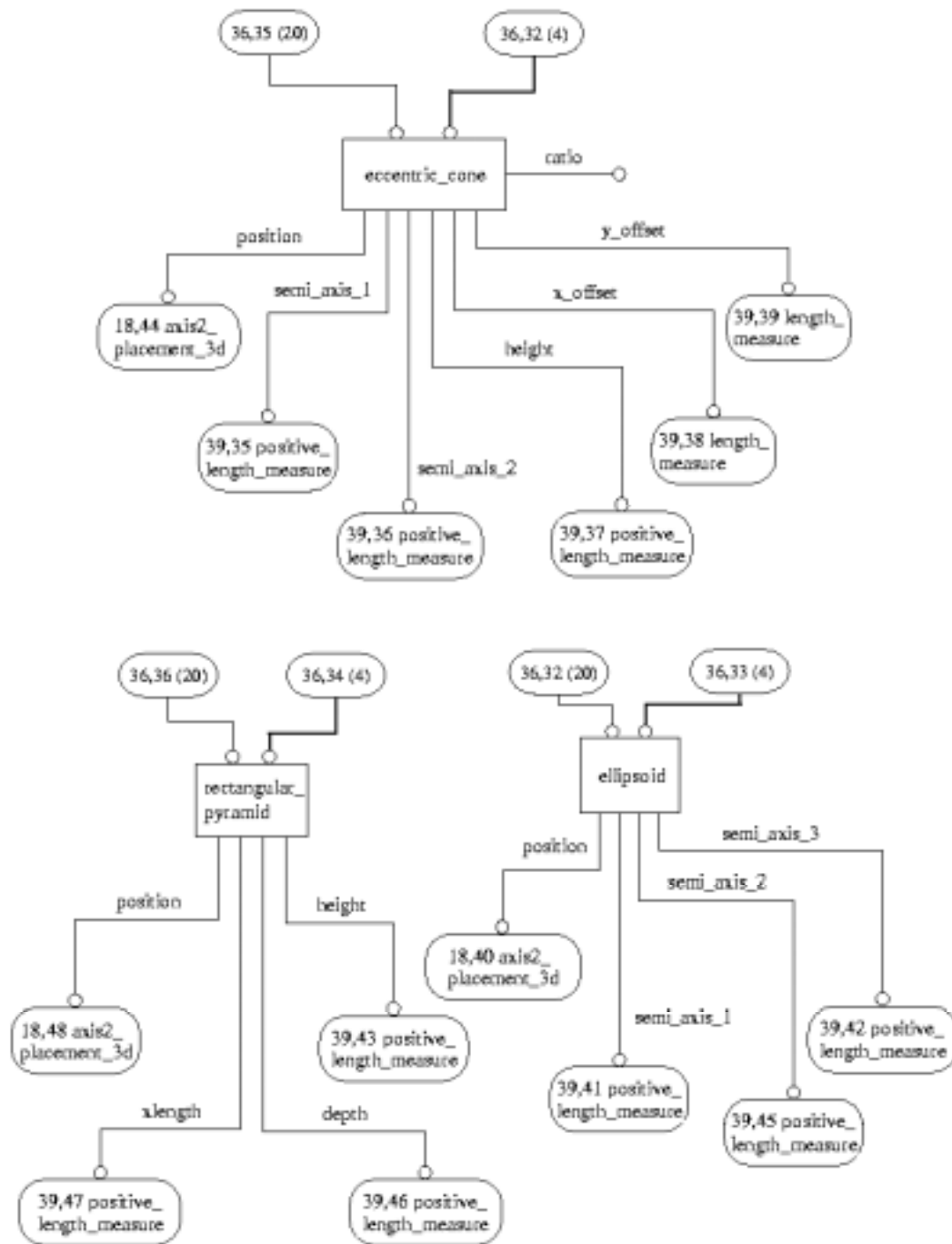


Figure H.36 - AIM EXPRESS-G diagram 36 of 41

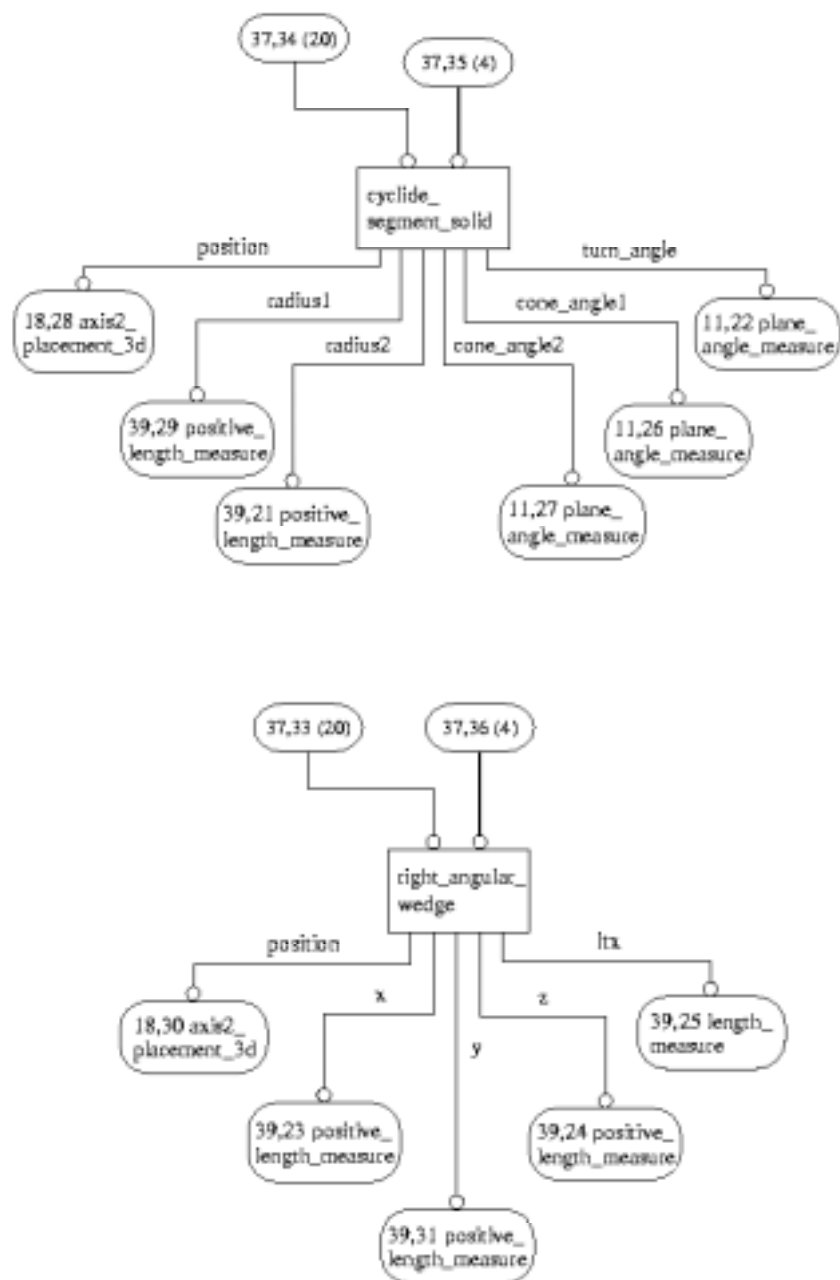


Figure H.37 - AIM EXPRESS-G diagram 37 of 41

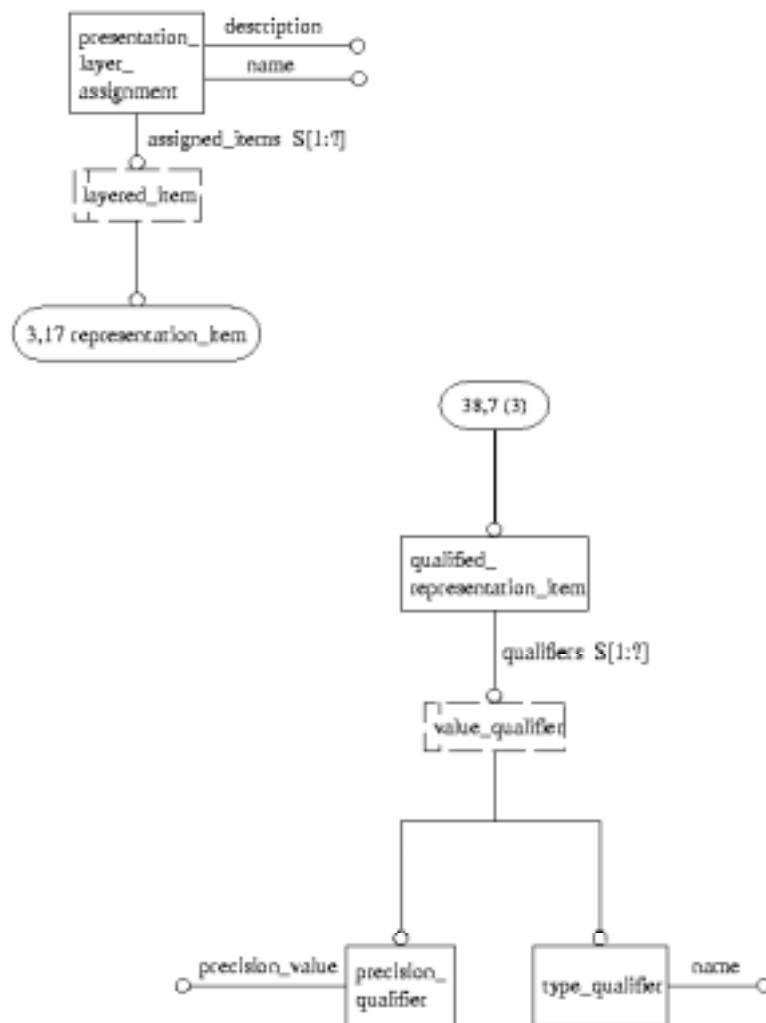


Figure H.38 - AIM EXPRESS-G diagram 38 of 41

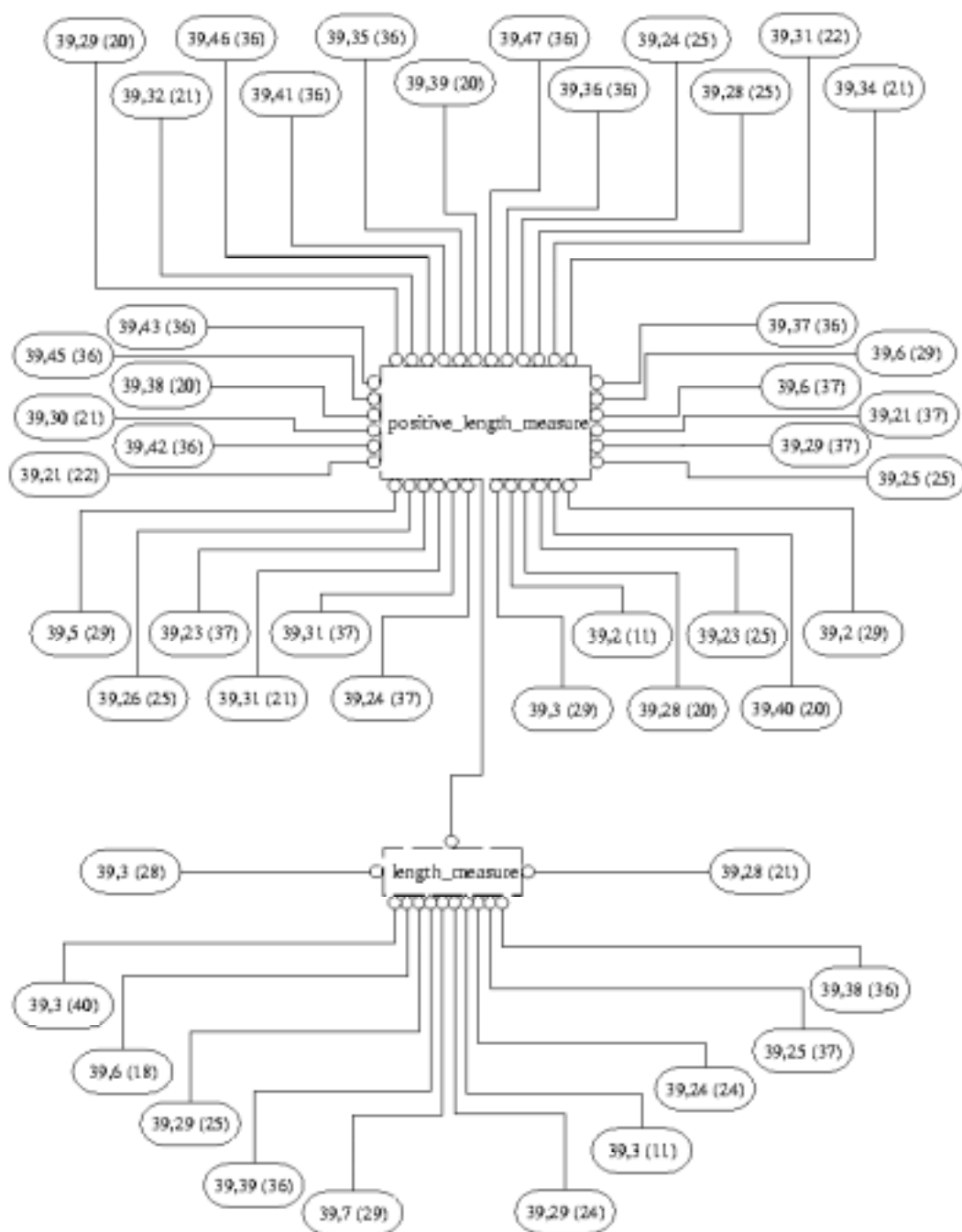


Figure H.39 - AIM EXPRESS-G diagram 39 of 41

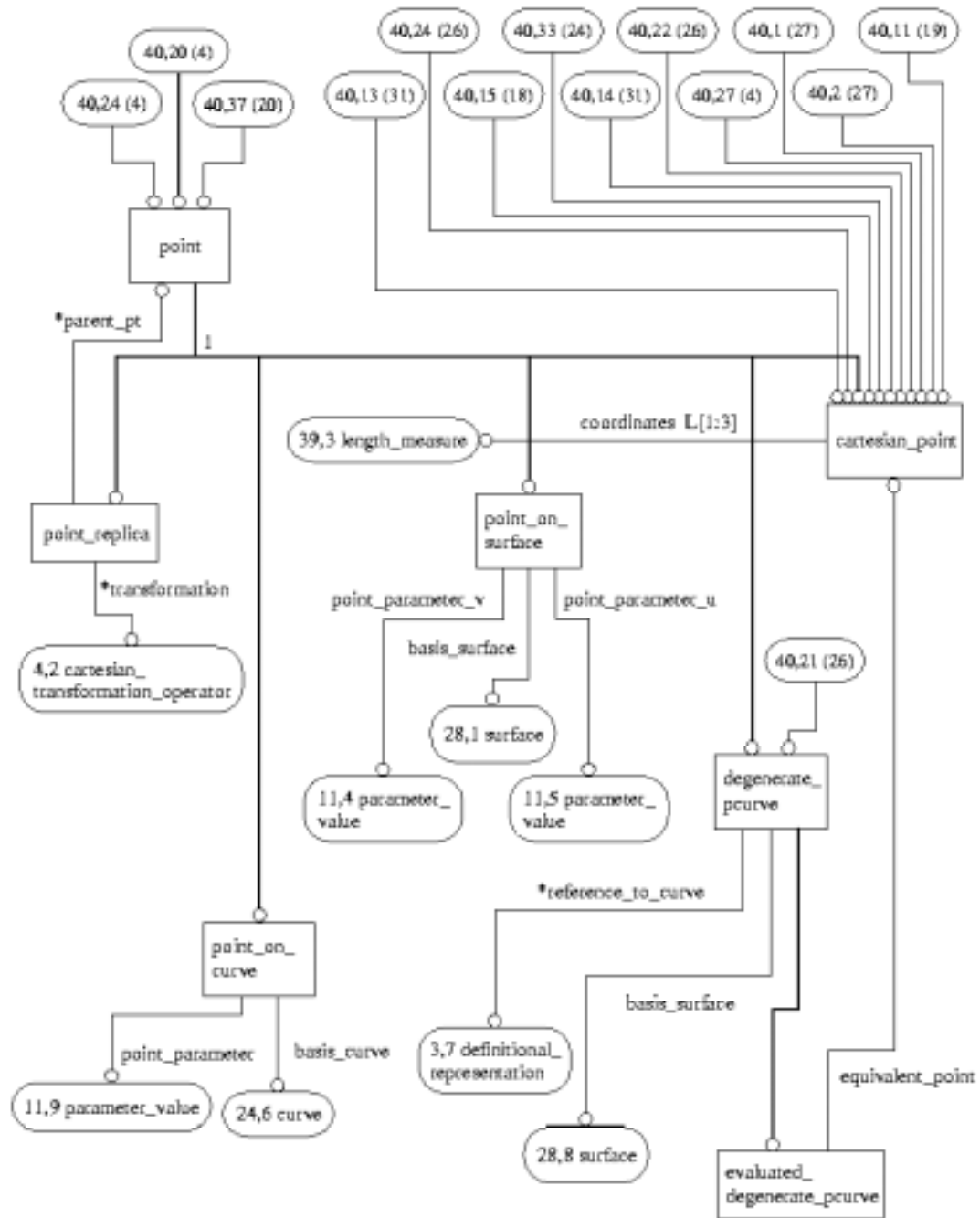


Figure H.40 - AIM EXPRESS-G diagram 40 of 41

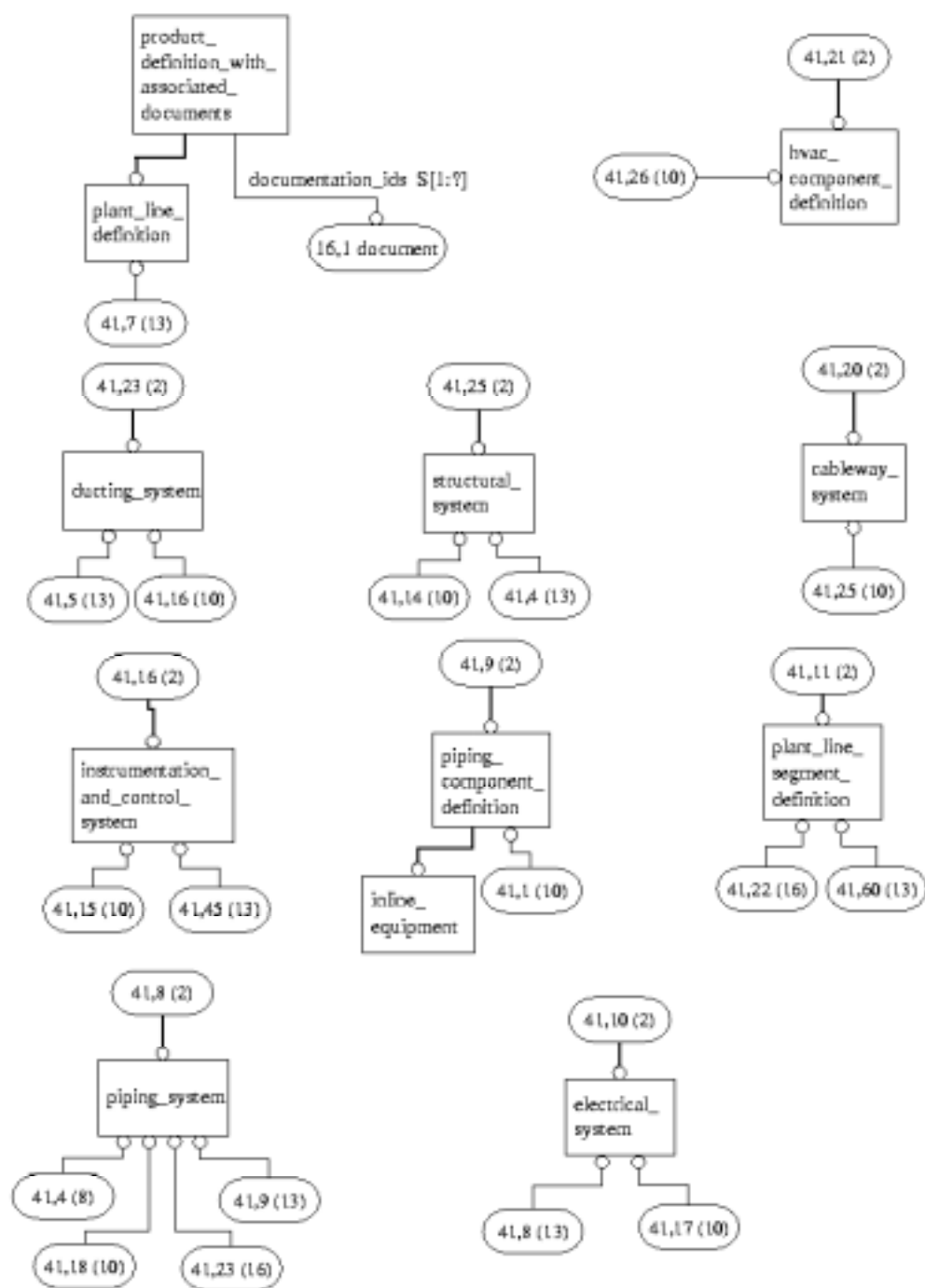


Figure H.41 - AIM EXPRESS-G diagram 41 of 41

**Annex J**  
(informative)

**AIM EXPRESS listing**

This annex provides a listing of the complete EXPRESS schema specified in annex A of this part of ISO 10303 without comments or other explanatory text. It also provides a listing of the EXPRESS entity names and corresponding short names as specified in annex B of this part of ISO 10303.

The content of this annex is available in computer-interpretable form and can be found at the following URLs:

- Short names: <http://www.mel.nist.gov/div826/subject/apde/snr/>
- EXPRESS: <http://www.mel.nist.gov/step/parts/part227e2/cd1/>

If there is difficulty accessing these sites contact ISO Central Secretariat or contact the ISO TC 184/SC4 Secretariat directly at: [sc4sec@cme.nist.gov](mailto:sc4sec@cme.nist.gov).

NOTE The information provided in computer-interpretable form at the above URLs is informative. The information that is contained in the body of this part of ISO 10303 is normative.

## **Annex K**

(informative)

### **Application protocol usage guide**

This annex provides an explanation and guidance on the usage of this part of ISO 10303. The annex is divided into sections; each section addresses a different important or high-value topic or capability of this part of ISO 10303.

NOTE The material in this annex differs from that in the Technical Discussion, annex L, in that the purpose of the material presented herein is to explain how to use this part of ISO 10303 in several important areas.

The guidelines provided in this annex are suggestions for best usage of this part of ISO 10303. They shall be interpreted by users of this standard as recommendations rather than as requirements.

NOTE A detailed Usage Guide for this part of ISO 10303 for Ship Piping has been published as a separate document [15].

#### **K.1 Identifiers**

Identifiers are alphanumeric labels that uniquely identify an instance of an entity within a given data population. The data population may be either (1) the boundaries of an exchanged data file, (2) the boundaries of a particular project, or (3) the life-cycle of a plant. The guidelines provided herein fully address (1), but only partially address (2) and (3) since the actions and policies involved in a design project or the life-cycle of a process plant are beyond the scope of this part of ISO 10303. These guidelines do not address the instance identifiers required by ISO 10303-21.

Identifiers as used within this part of ISO 10303 fall into two classes. One class are application object identifiers that are specified in Clause 4 and the ARM. These application object identifiers and their corresponding AIM identifier and recommended usage or interpretation are listed in table K.1. The second class are those that are specified in the AIM. These AIM identifiers and their corresponding ARM uses and recommended usages or interpretations are listed in table K.2.

All application object identifiers shall be unique within the context of an exchange file and should be unique within both a project and through the life-cycle usage of a process plant. The identifier may correspond to a product data identifier used in other representations of product data, such as a part number on a drawing. If the application object identifier does not correspond to a real world identifier, an identifier shall be fabricated based on policies and procedures of the particular project or plant. This identifier is more than a system generated identifier in that it should have persistence over time as the data is used and exchanged.

**Table K.1 - Application object identifiers**

<b>Application object identifier</b>	<b>AIM identifier</b>	<b>Recommended usage or interpretation</b>
Access_opening_id	shape_aspect.name	This attribute differentiates one Hvac_access_opening on an Hvac_component from another.
Branch_sequence_id	shape_aspect_relationship.name	This specifies an alphanumeric identifier that indicates the order that branches extend from the main Hvac_section_segment or the main Piping_system_line_segment.
Building_id	representation	This specifies a unique number used to identify the building.
Catalogue_id	document.id	This corresponds to a volume number or issue number or a date that uniquely identifies a published (i.e., configuration controlled) version of a catalogue. This value should be unique across the project and plant life cycle.
Change_id	action.name	This corresponds to designations such as Engineering Change Notice (ECN) numbers and similar codes used to identify, track, and control changes made to the design data. It is strongly recommended that it be unique throughout the life cycle of the plant.
Change_item_id	change_item_id_assignment (name_assignment.name)	Since a Change_item is not a new thing, the Change_item_id is an extra identifier associated with something that already exists. It does not correspond to any real world identifier. It is strongly recommended that the value of the attribute change_item_id_assignment (name_assignment.name) be unique throughout the life cycle of the plant.
Connecting_portion_id	identification_assignment.assigned_id	This specifies a descriptive identification of the area of the connection that is being inspected.
Connection_id	shape_aspect.name	A connection is a shape_aspect of the assembly that contains the connection. There may or may not be a real world identifier that corresponds to a particular connection in a plant system. If such an identifier does not exist, a value shall be fabricated to uniquely identify each connection.
Control_loop_id	product.id	This corresponds to a real world control loop number or designation. It should be unique within a project and plant life cycle.
Design_project_id	organization.id	This corresponds to a project code or some other identifier other than project number (a designation that maps to organization.description). This may be fabricated. It should be unique within the plant life cycle.

**Table K.1 - Application object identifiers - (continued)**

<b>Application object identifier</b>	<b>AIM identifier</b>	<b>Recommended usage or interpretation</b>
Document_id	document.id	This specifies a unique identification for the Document.
Element_id	representation_item.name	This does not correspond to any real world identifier. The closest real world equivalent would be the id of a geometric element in a CAD system. It may be considered a system identifier used to differentiate among geometric elements. A value may be fabricated if there is a need to uniquely identify a geometric element in a scope beyond a geometric model file.
Flow_control_device_id	product.id	This specifies a unique identifier for each of the inline control devices.
Hvac_section_id	product_definition.id	This specifies a unique identifier for the Hvac_section_segment.
Hvac_specification_id	document.id	This attribute specifies a designation that differentiates one Hvac_specification from another.
Instrument_id	product.id	This attribute specifies the unique identifier for each Hvac_instrument.
Interference_id	product_definition_relationship.name	If two plant_items clash, there is a product_definition_relationship defined between them. This does not correspond to any real world identifier. It should be fabricated, but there is probably little need for it to be unique across a project or plant life cycle.
Line_to_line_connection_id	shape_aspect_relationship.name	This does not correspond to any real world identifier. It may be considered a system identifier used to differentiate among connections between line segments.
Location_id	representation_item.name	A plant_item is located in a plant with a mapped_item as a representation. Hence, representation_item is used and location_id maps to representation_item.name. This does not correspond to any real world identifier.
Material_requirement_id	product.id	This is the identifier of the material required by or for a plant_item. The material is considered as a product. It corresponds to a real world designation, but is not equivalent to a material specification identifier. It may be the part number of raw stock or a chemical designation like H <sub>2</sub> O.
Material_specification_id	document.id	This corresponds to the identifier of a material specification or manual, e.g., ASTM A403.
Operating_case_id	property_definition_relationship.name	This is a fabricated identifier that does not correspond to any real-world identifier. It is used only to differentiate among service_operating_cases.
Piping_specification_id	document.id	This corresponds to the identifying designation of a piping specification. It is strongly recommended that it be unique throughout the project and plant life cycle.

**Table K.1 - Application object identifiers - (continued)**

<b>Application object identifier</b>	<b>AIM identifier</b>	<b>Recommended usage or interpretation</b>
Piping_ system_line_id	product_definition.id	This is a fabricated designation that should have a one-to-one correspondence with the line number. It is used in addition to line number because line numbers sometimes have minor variations, e.g., Line 111a, Line 111-1.
Plant_id	product.id	This corresponds to the identifying designation given to a plant, if such a designation exists. If not, a value may be fabricated. There should be a one-to-one correspondence between this value and the plant name.
Plant_item_id	product_definition.id	<p>Most often this will be interpreted as a Part Number. The specific interpretation depends on usage:</p> <p>Functional Design View - Plant Item Definition This value must be fabricated. There is no real-world equivalent in common use.</p> <p>Functional Design View - Plant Item Instance This value must be fabricated. It may be associated with zero or one TAG Number.</p> <p>Physical Design View - Plant Item Definition This value may be fabricated, but it typically corresponds to a Part Number.</p> <p>Physical Design View - Plant Item Instance This value may be fabricated, but it corresponds to the use of a part in a design (i.e., instance number). It may be associated with zero or one serial number.</p>
Plant_item_ connector_id	shape_aspect.name	A connector is a shape_aspect of a plant_item. There may or may not be a real world identifier that corresponds to a particular connector of a plant system. If such an identifier does not exist, a value shall be fabricated to uniquely identify each connector.
Plant_process_ capability_id	property_ definition.name	This does not correspond to any real world identifier. It may be considered a system identifier used to differentiate among process capabilities.
Plant_system_ id	product.id	This corresponds to a unique designation given to a system within a plant. It is strongly recommended that it be unique within a project and throughout the plant life cycle.
Reference_ geometry_id	representation_ item.name	This does not correspond to any real world identifier. It may be considered a system identifier used to differentiate among reference geometry.

**Table K.1 - Application object identifiers - (continued)**

<b>Application object identifier</b>	<b>AIM identifier</b>	<b>Recommended usage or interpretation</b>
Section_to_section_connection_id	shape_aspect_relationship.name	This specifies a unique identifier of the connection between two Hvac_section_segments.
Segment_id	product_definition.id	This is a fabricated designation that may or may not correspond to a real world designation. It is used principally to differentiate between segments of a line.
Selection_id	document_usage_constraint.subject_element	This corresponds to a table number, chapter number, line or row number, section number, or some other designation that identifies a particular portion of a material specification or manual.
Set_id	product_definition.id	This specifies a unique identifier for a Bolt_and_nut_set or a Clamp_set.
Shape_id	property_definition.name	Shape is a property of a plant_item. This does not correspond to any real world identifier, though it may be interpreted as a unique file name or drawing number for different representations of the shape of a plant_item.
Site_feature_id	property_definition.name	This may or may not correspond to a real world identifier. It may be fabricated to differentiate among site features. A site feature is a property of a site.
Site_id	characterized_object.name	This corresponds to designations that identify a site or plot of land. Examples include municipal plot or tract designations or GIS descriptions. Sites cannot be defined unless they are associated with a plant. The value may be fabricated for a particular project or plant life cycle.
Source_id	external_source.source_id	This specifies a unique identification of the external origin of the Document.
Splitter_id	shape_aspect.name	This attribute specifies a unique identifier for the Splitter.
Stream_design_id	characterized_object.name	This may or may not correspond to a real world identifier. It uniquely identifies the definition of particular stream states. A value may be fabricated if there is a need to uniquely identify a stream state (i.e., design case) across a project or plant life cycle.
Subset_id	document_relationship.name	This corresponds to a subsection reference or other designation that identifies a portion of a material specification.
Supplier_id	organization.id	This corresponds to a designation that uniquely identifies a supplier to a project or plant life cycle.
Support_constraint_id	representation.name	This does not correspond to any real world identifier. It may be considered a system identifier used to differentiate among support components.

**Table K.1 - Application object identifiers - (continued)**

<b>Application object identifier</b>	<b>AIM identifier</b>	<b>Recommended usage or interpretation</b>
Termination_id	shape_aspect.name	This does not correspond to any real world identifier. It may be considered a system identifier used to differentiate among terminations used to connect line segments.
Version_id	identification_assignment.assigned_id	This specifies a unique identification of a revision of a particular Document.
Weld_id	identification_assignment.assigned_id	This specifies an identification of the weld point at which the inspection is being made.

**Table K.2 - AIM identifiers**

AIM identifier	ARM uses	Recommended usage or interpretation
document.id	catalogue_id piping_ specification_id material_ specification_id	As mapped.
organization.id	Design_project_id Supplier_id	As mapped.
person.id	none	Although individuals are not explicitly identified in the ARM, attributes such as approval.approver require the person entity. A unique value should be fabricated to differentiate among persons.
product.id	Control_loop_id Plant_id Plant_system_id Material_ requirement_id	As mapped.
product_ definition.id	Plant_item_id Piping_system_ line_id Segment_id	As mapped.
product_ definition_ formation.id	None	This may or may not correspond to a real world identifier. It is used to differentiate among versions of product design.
product_ definition_ formation_ relationship.id	None	This does not correspond to a real world identifier. A value shall be fabricated to differentiate among product_definition_formation_relationships.
product_ definition_ relationship.id	None	This does not correspond to a real world identifier. A value shall be fabricated to differentiate among product_definition_formation_relationships.
representation_ context.context_ identifier	None	This does not correspond to a real world identifier. A value shall be fabricated that is unique to a specific type of context and differentiates among local coordinate systems.
versioned_ action_request.id	None	This may or may not correspond to a real world identifier. If it does, it may correspond to an identifier found on a change request.

## K.2 Units

Most measures will be expressed in terms of SI units. For units such as inches, instances of conversion\_based\_unit must be used. Figure K.1 contains a fragment of the EXPRESS-G for the

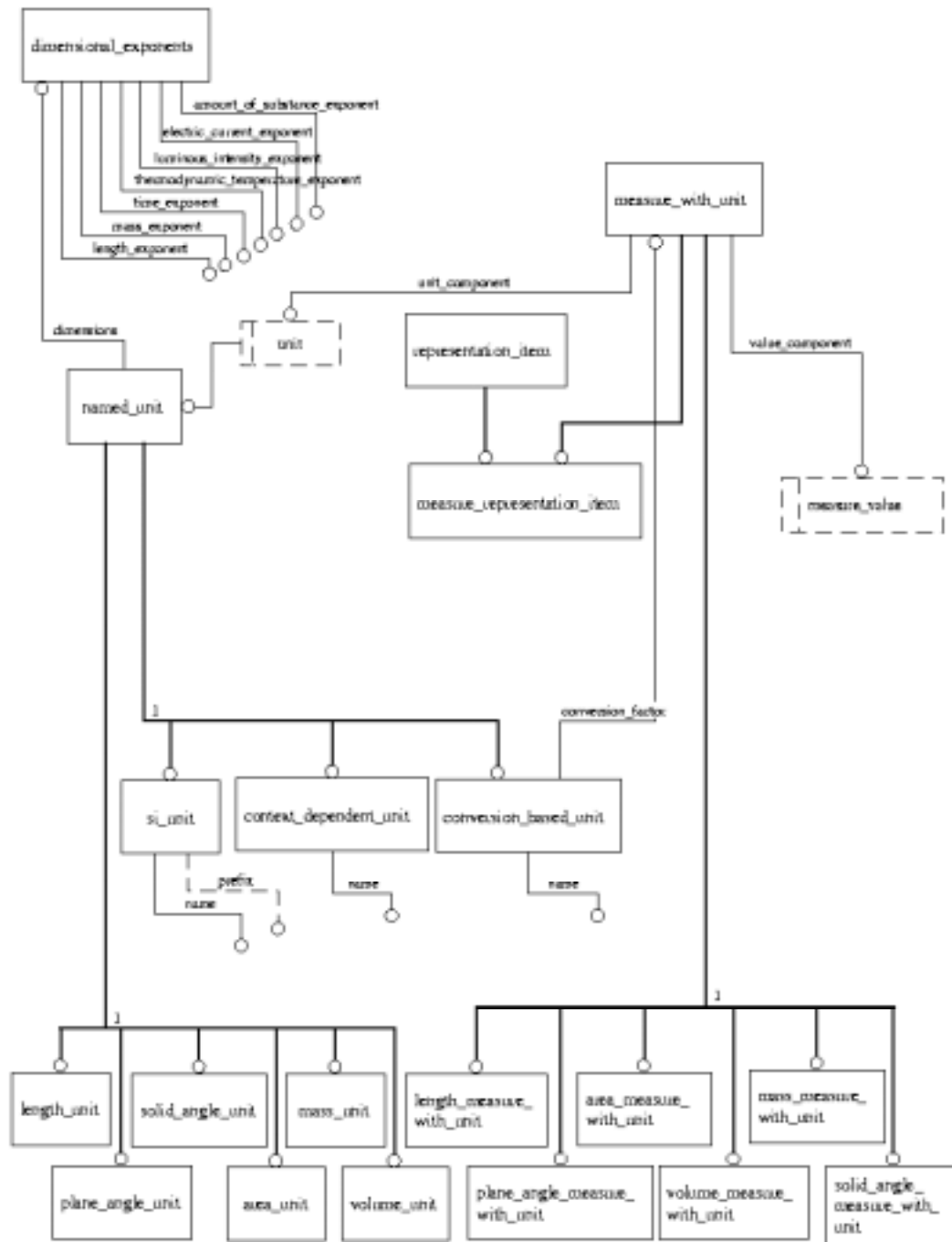


Figure K.1 - Fragment of measure\_schema in EXPRESS-G

measure schema (see ISO 10303-41). Compare the EXPRESS with the following fragment of an ISO 10303-21 data file:

```
/* length dimension's exponent = 1 */
#22=DIMENSIONAL_EXPONENTS(1.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0);
#200=(LENGTH_UNIT()NAMED_UNIT(#22)SI_UNIT(.MILLI.,METRE.));
/* Inches unit - length measure*/
/* conversion factor from mm to inches: 1 inch = 25.4 mm */
#201=LENGTH_MEASURE_WITH_UNIT(LENGTH_MEASURE(25.4),#200);
/* specifies length unit - based on conversion from millimeters */
#202=(CONVERSION_BASED_UNIT('inches',#201)LENGTH_UNIT()NAMED_UNIT
(#22));
```

The units that the conversion is based upon are millimetres. The units are represented by instance #200. This instance is:

- a named unit with dimensional exponents of length;
- a length\_unit; and
- a SI unit: millimetre.

Instance #201 represents the conversion of millimetre values to another value. The conversion factor is 25.4, meaning that millimetres are multiplied by 25.4 to yield another value.

Instance #202 applies the name of "inches" to the converted value. It is also a named unit (with dimensional exponents of length) and a length unit.

Note that these data are not a *converted* value, but rather are the specification of a unit (inches in #202) derived from a known SI unit. Measures that use inches would reference #202. For example, the datum:

```
/* Nominal size = 0.5" */
#100=(LENGTH_MEASURE_WITH_UNIT()
MEASURE_REPRESENTATION_ITEM()
MEASURE_WITH_UNIT(LENGTH_MEASURE(0.5),#202)
REPRESENTATION_ITEM());
```

Represents a nominal size of one-half inch because it references #202 as the unit component.

#### Axis\_placement

Position and orientation of objects within a geometric coordinate system are either inherently part of the geometric definition of the object or are defined through a transformation mechanism. The position and orientation mechanisms used for transformation in ISO 10303-42 are cartesian\_points and the "placement" entities. EXPRESS definitions of the 3D versions of these placement entities are:

#### ENTITY placement

```
SUPERTYPE OF (ONEOF(axis1_placement,axis2_placement_2d,axis2_placement_3d))
SUBTYPE OF (geometric_representation_item);
location : cartesian_point;
END_ENTITY;
```

```

ENTITY axis2_placement_3d
  SUBTYPE OF (placement);
  axis      : OPTIONAL direction;
  ref_direction : OPTIONAL direction;
  DERIVE
    p      : LIST [3:3] OF direction := build_axes(axis,ref_direction);
  WHERE
    WR1: SELF\placement.location.dim = 3;
    WR2: (NOT (EXISTS (axis))) OR (axis.dim = 3);
    WR3: (NOT (EXISTS (ref_direction))) OR (ref_direction.dim = 3);
    WR4: (NOT (EXISTS (axis))) OR (NOT (EXISTS (ref_direction))) OR
      (cross_product(axis,ref_direction).magnitude > 0.0);
  END_ENTITY;

```

The entity `axis2_placement_3d` is location point (`SELF\placement.location.dim`) and a set of orthogonal axes defined by the derived attribute `axis2_placement_3d.p`. The derivation uses the Z axis specified by the attribute `axis2_placement_3d.axis` and, optionally, an approximate X axis specified by the `axis2_placement_3d.ref_direction` to construct a set of orthogonal axes. The following fragment of an ISO 10303-21 data file illustrates a set of axes at the origin:

```

#20=CARTESIAN_POINT('origin point',(0.0, 0.0, 0.0));
#40=DIRECTION('X',(1.0,0.0,0.0));
#41=DIRECTION('Y',(0.0,1.0,0.0));
#42=DIRECTION('Z',(0.0,0.0,1.0));
#66=AXIS2_PLACEMENT_3D('generic origin',#20,#42,#40);

```

K.4 describes how `axis2_placements` are used for positioning and orientation of shape representations.

### K.3 Mapped\_item and representation\_item

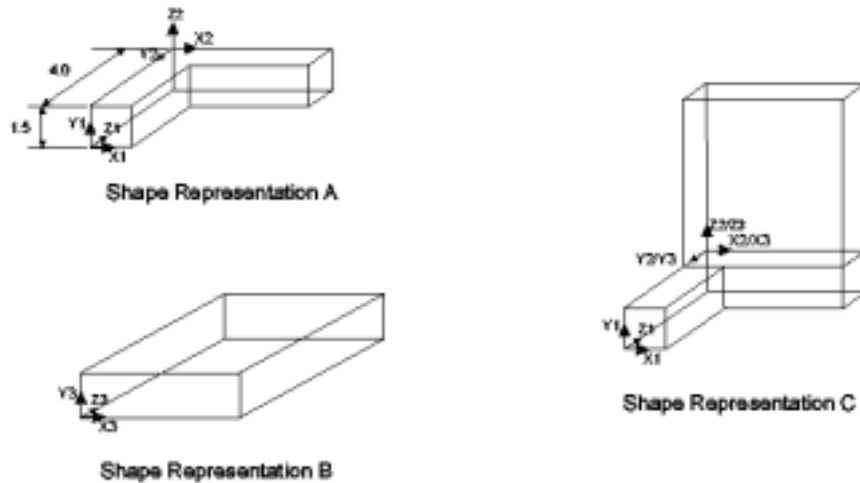
Figure K.2 illustrates how the shape representation of one object is positioned and oriented in another shape representation. The positioning is accomplished by "superimposing" an `axis2_placement_3d` (A3: (X3, Y3, Z3)) in one shape representation (SR-B) onto another `axis2_placement_3d` (A2: (X2, Y2, Z2)) in a different shape representation (SR-C). Since A2 is positioned relative to all the geometric elements in SR-C, placing and orienting A3 so that it corresponds to A2 in SR-C will produce the effect of positioning SR-B in SR-C. This is accomplished with `mapped_item` and `representation_item`.

The EXPRESS for `mapped_item` and `representation_map` are as follows:

```

ENTITY mapped_item
  SUBTYPE OF (representation_item);
  mapping_source : representation_map;
  mapping_target : representation_item;
  WHERE
    wr1: acyclic_mapped_representation(using_representations(SELF),
      [SELF]);
  END_ENTITY; -- mapped_item

```



**Figure K.2 - Positioning of shape representations**

```

ENTITY representation_map;
  mapping_origin    : representation_item;
  mapped_representation : representation;
INVERSE
  map_usage : SET [1:?] OF mapped_item FOR mapping_source;
WHERE
  wr1: item_in_context(SELF.mapping_origin,SELF.mapped_representation,
    context_of_items);
END_ENTITY; -- representation_map
Using the data from above plus unit information:

```

```

#1=GLOBAL_UNIT_ASSIGNED_CONTEXT('contxtid:c1','contxttype: length',( #2));
#2=(LENGTH_UNIT()NAMED_UNIT(#3)SI_UNIT(.MILLI.,.METRE.));
#3=DIMENSIONAL_EXPONENTS(1.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0);
#20=CARTESIAN_POINT('origin point',(0.0, 0.0, 0.0));
#40=DIRECTION('X',(1.0,0.0,0.0));
#41=DIRECTION('Y',(0.0,1.0,0.0));
#42=DIRECTION('Z',(0.0,0.0,1.0));
#66=AXIS2_PLACEMENT_3D('generic origin',#20,#42,#40);

```

The shape\_representation of A from figure K.2 is:

```

#100=CARTESIAN_POINT('location of block B',(0.0, 1.5, 4.0));
#101=AXIS2_PLACEMENT_3D('orientation of block B',#100,#41,#40);
#105=SHAPE_REPRESENTATION('shape representation A',(#66, #101, <shape of L-
  shape block>),#1);

```

Things to note about these data include:

— cartesian\_point #100 as used in axis2\_placement\_3d #101 (A2) is the position of A2 and, thus, of shape representation B (SR-B).

— the Z axis of the axis2\_placement\_3d #101 *points in the Y direction* within shape representation A. This is very significant because by aligning the Z axes of A3 in shape representation B and A2 in shape representation A, the desired orientation of shape representation B in shape representation C is achieved.

— for simplicity, the explicit geometry of the L-shaped block is not included in shape representation #105.

The shape representation of B is:

```
#110=SHAPE_REPRESENTATION('shape representation B',(#66, <shape of
block>),#1);
```

Things to note about this datum include:

— the origin axes of both shape representation A #105 and shape representation B #110 are the same. This does not present a conflict because the same data is simply used differently, i.e., used in different contexts. The shape representation contexts of both of the representations are different. No assumption shall be made concerning the relationship of these axes unless they are made to be part of the same context.

The shape representation of C requires the use of representation\_item and mapped\_item.

```
#120=REPRESENTATION_MAP(#66,#110);
#121=MAPPED_ITEM('positioned shape B in C',#120,#101);
#122=SHAPE_REPRESENTATION('shape representation C',(<shape of L-shaped
block>, #121),#1);
```

Things to note about these data include:

— representation\_map #120 specifies the base mapping information: the mapped\_representation #110 and the mapping\_origin, #66. The mapping\_origin is the element *in the representation* of the mapped\_representation that is used to position and orient the shape. Most often this will be a set of axes at the origin, but it may be other things as well.

— mapped\_item #121 specifies the mapping transformation. The mapping\_source is the representation\_map to be transformed. The mapping\_target is the *destination* of the transformation. The representation\_map is moved such that the axis2\_placement\_3d.location of the mapping\_origin is at, on top of, or corresponds with the axis2\_placement\_3d.location of the mapped\_item.mapping\_target. Similarly, the representation\_map is rotated such that the axes of the mapping\_origin are aligned with the axes of the mapped\_item.mapping\_target.

— the shape representation C consists of the L-shaped block, that is the same shape representation element used for shape representation A, and the mapped\_item #121, that is the positioned shape of shape representation B.

This is just one approach for positioning the shape representation of objects within other shape representations. It is strongly recommended that `axis2_placement_3d` objects be used for the `representation_map.mapping_origin` and `mapped_item.mapping_target`.

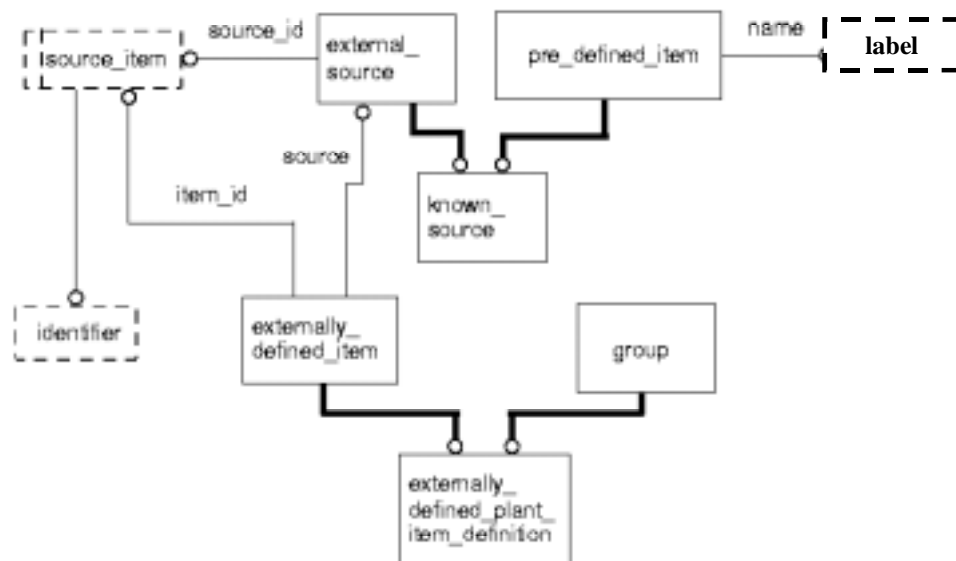
## K.4 Interfaces to ISO 13584 and ISO 10303-221

This part of ISO 10303 may be used in conjunction with ISO 13584 [13] to identify catalogue items (Parts Libraries) and classifications, and with ISO 10303-221, annex M [3], to classify plant items, plants, plant systems, and connectors. With respect to this part of ISO 10303, both ISO 13584 [13] and ISO 10303-221 are considered as external sources and are referenced using `known_source` (see ). A `known_source` is both an `external_source` and a `pre_defined_item` (see ). It is used for referencing ISO 13584 because ISO 13584 is an external source of information with respect to this part of ISO 10303 and is also pre-defined with respect to this part of ISO 10303.

ISO 10303-221 is referenced only as an external source. It is not pre-defined with respect to this part of ISO 10303 for reasons that are not explained here because they are not germane to the annex K or to this part of ISO 10303.

In the following explanation, the only difference between a reference to ISO 13584 and ISO 10303-221 is that a reference to ISO 13584 is a complex instance consisting of `external_source`, `known_source`, and `pre_defined_item` and a reference to ISO 10303-221 is a simple instance of `external_source`. `Pre_defined_item` and `known_source` are used to explicitly list the names of the allowable external sources in this part of ISO 10303.

The EXPRESS code for the external source is presented below. Figure K.3 shows the EXPRESS-G version.



**Figure K.3 - Known\_source for externally defined items**

```

ENTITY external_source;
    source_id : source_item;
END_ENTITY; -- external_source

ENTITY pre_defined_item;
    name : label;
END_ENTITY; -- pre_defined_item

ENTITY known_source
    SUBTYPE OF (external_source, pre_defined_item);
    WHERE
        wr1: SELF\pre_defined_item.name IN ['ISO 13584 Dictionary',
            'ISO 13584 Parts Library'];
END_ENTITY; -- known_source

TYPE source_item = SELECT
    (identifier);
END_TYPE; -- source_item

ENTITY externally_defined_item;
    item_id : source_item;
    source : external_source;
END_ENTITY; -- externally_defined_item

ENTITY externally_defined_plant_item_definition
    SUBTYPE OF (product_definition, externally_defined_item);
END_ENTITY; -- externally_defined_plant_item_definition

```

For plant items that are defined externally to the exchange file (e.g., as in a reference to a part in a part library or to a catalogue item), the EXPRESS would be used as shown in table K.3.

**Table K.3 - EXPRESS for externally defined plant items**

<b>EXPRESS</b>	<b>Explanation</b>	<b>Example</b>
known_source/- predefined_item.name	Provides the name of the known external source.	Example: 'ISO 13584 Parts Library'
known_source/external_ source.source_id	Identifies the external source.	Example: 'ISO 13584-21:1996'
known_source	The complex instance that represents the external source.	Example: #10=(known_source() pre_defined_item('ISO 13584 Parts Library') external_source('ISO 13584-21:1996'))
externally_defined_item.- source	References the known_ source that contains the externally defined item.	Example: references ("points at") the known_source for ISO 13584, #10 above.
externally_defined_ item.item_id	Identifies the item within the known_source.	Example: 'Reciprocating Pump Model 100'
externally_defined_item/- product_definition/- externally_defined_plant_ item_definition	The complex instance that represents an externally defined item in an exchange file using the AP 227 AIM.	Example: a reference to a catalogue item within a use of this part of ISO 10303.

Externally defined classifications follow the same approach substituting group for product\_  
definition:

```

ENTITY externally_defined_classification
  SUBTYPE OF (group, externally_defined_item);
  WHERE
    wr1: SIZEOF(QUERY ( ca <* QUERY ( ga <* USEDIN(SELF,
      'PLANT_SPATIAL_CONFIGURATION.GROUP_ASSIGNMENT.ASSIGNED_GROUP')
      | ('PLANT_SPATIAL_CONFIGURATION.CLASSIFICATION_ASSIGNMENT'
      IN TYPEOF(ga)) ) | (NOT (SIZEOF(QUERY ( it <* ca.items | (
      NOT ((SIZEOF(TYPEOF(it) * [
      'PLANT_SPATIAL_CONFIGURATION.ELECTRICAL_SYSTEM',
      'PLANT_SPATIAL_CONFIGURATION.DUCTING_SYSTEM',
      'PLANT_SPATIAL_CONFIGURATION.INSTRUMENTATION_AND_CONTROL_SYSTEM'
      ,
      'PLANT_SPATIAL_CONFIGURATION.PIPING_SYSTEM',
      'PLANT_SPATIAL_CONFIGURATION.PLANT',
      'PLANT_SPATIAL_CONFIGURATION.PLANT_ITEM_CONNECTOR',
      'PLANT_SPATIAL_CONFIGURATION.PIPING_COMPONENT_DEFINITION',

```

```

'PLANT_SPATIAL_CONFIGURATION.STRUCTURAL_SYSTEM']) = 1) OR ((
'PLANT_SPATIAL_CONFIGURATION.PRODUCT_DEFINITION' IN TYPEOF(
it)) AND (SIZEOF(QUERY ( pc <= it.formation.of_product.
frame_of_reference | (pc.discipline_type = 'process plant') ))
= 1)))) = 0)) = 0;
END_ENTITY; -- externally_defined_classification

```

Figure K.3 shows the EXPRESS-G for the external classification.

## K.5 Precedence of geometric descriptions

There are three principal methods for specifying the geometric shape of a plant item:

- explicit geometric representation;
- parametric representation;
- catalogue item identification.

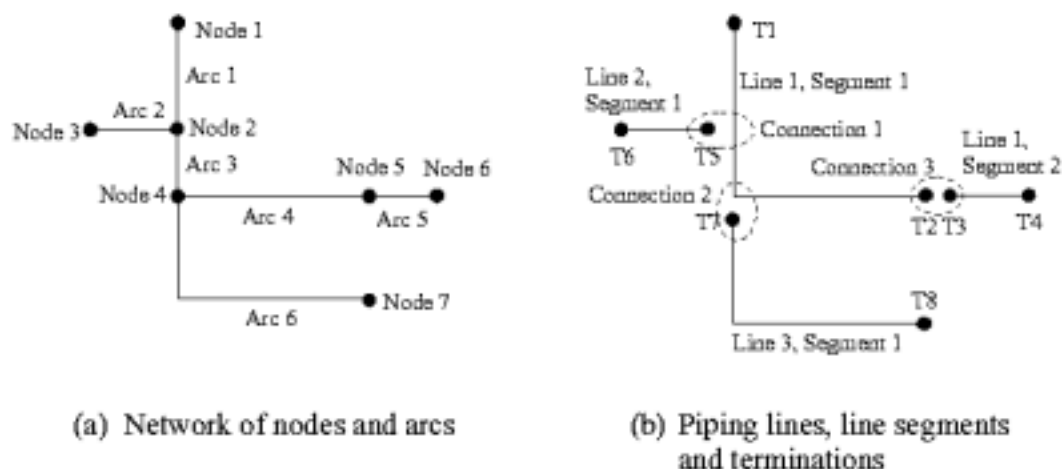
A explicit geometric representation is the wireframe, b-rep, or csg geometry (or combination thereof) that is specified as the shape of a plant item. Parametric representation may be used for fittings. This representation specifies values for certain dimensional parameters of common fittings like elbows and reducers. A catalogue item identification uses neither explicit geometry or parametric values, but rather identifies a catalogue item that is commonly understood between partners in a data exchange. In an exchange using this part of ISO 10303, all three representations may be simultaneously used. This leads to a question of precedence among the representations, particularly if there is a conflict.

There is no absolute ordering with respect to which of these representations take precedence. Rather precedence depends on the use of the geometric representation. For example, for CAD display purposes, the explicit geometry, if present, should take precedence over the parametric representation or catalogue identification. Parametric representations should take precedence over explicit geometry when connectivity checks of mating conditions are performed.

In general, since a catalogue item identification would, presumably, identify a specific plant item design that is commonly understood between partners, the shape indicated or determined by the catalogue item identification, if present, should take precedence over the explicit geometry (since it subject to errors) and the parametric representation (because it is an approximate representation of the shape.)

## K.6 Lines and line segments

The purpose of this part of ISO 10303 is not to exchange piping line information equivalent to that of a P&ID, but only that subset of information necessary for piping design. In this part of ISO 10303, piping lines specify the logical connectivity and some of the characteristics of process streams. The piping lines (*piping\_system\_lines*) are a network of logical nodes and arcs analogous to those found on a P&ID. Figure K.4 (a) illustrates piping lines as a network of nodes and arcs. These networks are purely logical and exist in the figure solely for the purpose of illustration. There are no geometric representations intended or implied.



**Figure K.4 - Piping line network**

A piping system line, typically identified with a line number, is composed of a set of connected piping system line segments. Other piping system lines may branch from a given line, forming a piping network. In general, a piping system line segment is distinguished by the fact that the process stream has uniform characteristics over the length of the segment.

Nodes exist at:

- equipment inlets and outlets;
- line inlets and outlets (e.g., drains and vents);
- significant changes in the characteristics of the process stream;
- junctions.

Equipment and line inlets and outlets are natural nodes for a piping system line. A significant change in the characteristics of the process stream also merits a node. Reducers, for example, correspond to a single segment with nodes at each end.

Junctions are divergences or confluences of a single line. Branches are treated a little differently in this part of ISO 10303 when compared to ISO 10303-221 [3]. Since nodes represent a significant change in stream conditions, there may not be a node at a minor branch. In this case, the branch line segment connects to the main line at some point other than at a termination node. Figure K.4 (b) illustrates this. Line 2 and line 3 (each consisting of a single line segment) are branches from line 1. They are connected at line\_branch\_connections.

Figure K.4 (b) also illustrates connections between piping system line segments. The three dotted ellipses represent two kinds of connections. Each line segment has a pair of terminations. Line branch connections, as described above, are connections between a termination on a branch and the line segment that it branches from. Connections between line segments, as shown in connection 3, are two or more segment terminations.

## **Annex L** (informative)

### **Technical discussions**

This annex provides discussions of certain technical aspects of this part of ISO 10303 for the purpose of clarifying those aspects.

NOTE The material in this annex differs from that in the Usage Guide, annex K, in that the purpose of the material here is to explain technical aspects of the design of this part of ISO 10303 that may be confusing or unclear as a result of the documentation format.

#### **L.1 Fitting parameters and nominal size**

The shape of fitting piping components may be defined parametrically in this part of ISO 10303. There are three aspects to this parametric definition:

- Fitting parameters;
- Connector parameters;
- Piping size description.

Fitting parameters are attributes of fitting application objects, such as an Elbow, defined in 4.2. An Elbow is defined by the attributes:

- centre\_to\_end\_1\_length;
- centre\_to\_end\_2\_length;
- centreline\_radius;
- end\_1\_connector;
- end\_2\_connector;
- sweep\_angle;
- type.

Centre\_to\_end\_1\_length, centre\_to\_end\_2\_length, centreline\_radius, and sweep\_angle are fitting parameters. End\_1\_connector and end\_2\_connector are connectors (or references to connectors) that have parameters of their own depending on the end type (e.g., socket, flange). Type is a label that classifies or describes the Elbow.

Each connector of the Elbow may have its own set of parameters. If one end of the Elbow was flanged, the parameters at the flanged end would be:

- flange\_inside\_diameter;

- flange\_outside\_diameter;
- flange\_thickness;
- raised\_face\_diameter;
- raised\_face\_height;
- ring\_bottom\_radius;
- ring\_diameter;
- ring\_width.

If the other end of the elbow was a socket, the parameters at the socket end would be:

- depth;
- hub\_inside\_diameter;
- hub\_length;
- hub\_outside\_diameter.

For piping components, the specification of a nominal size is a very important and very common approach to specifying the shape of the component. This is done with the piping\_size\_description application object. The attributes for this object are:

- dimensional\_standard;
- ovality\_allowance.

The four kinds of piping size descriptions are inside\_and\_thickness, outside\_and\_thickness, pressure\_class, and schedule. The attributes for the inside\_and\_thickness object are:

- inside\_diameter;
- thickness.

The attributes for the outside\_and\_thickness object are:

- outside\_diameter;
- thickness.

The attributes for the pressure\_class object are:

- nominal\_size;
- pressure\_rating.

The attributes for the schedule object are:

- nominal\_size;
- pipe\_schedule.

All of the attributes of piping size description and the four kinds of piping size descriptions are parameters, except for dimensional standard and pipe schedule, that are references to documents. It is important to note that nominal size, as used in this part of ISO 10303, has the same meaning as the term used in process plant industry. It does not denote an actual dimension of a component (as does "outside diameter"), but rather is an approximation or description of the size of the component.

A piping size description may be applied to a piping component in its entirety or to an individual connector on a piping component. Therefore, conflicts may arise between the specification of a piping size description and the fitting or connector parameters. This part of ISO 10303 does not specify a precedence among these representations in the case of conflicts. Precedence needs to be resolved on a case-by-case or project-wide basis.

## L.2 Value range, family definitions and range values

Dimensions, fitting parameters, and nominal sizes are typically associated with a single value.

**EXAMPLE** Single values for weld neck flange attributes are:

- hub through length: 5 inches
- hub weld point diameter: 3 inches
- flange inside diameter: 1.5 inches
- flange outside diameter: 8 inches
- flange thickness: 0.75 inches

There are occasions, however, when a family of parts needs to be described, such as in a piping specification.

**EXAMPLE** A range of values for the attributes of a family of weld neck flanges are:

- hub through length: 5 inches
- hub weld point diameter: 3 inches
- flange inside diameter: 1 to 2 inches
- flange outside diameter: 6 to 8 inches
- flange thickness: 0.75 to 1.25 inches

This part of ISO 10303 supports the specification of a range of values (i.e., a "value range") for a given dimension, parameter, or nominal size for the purpose of defining a family of parts. This is done by specifying two dimensional values for a given parameter. One dimension has a representation\_item.name with a value of "minimum\_<parameter name>" (e.g., "minimum\_flange\_inside\_diameter") and the other has a representation\_item.name with a value of "maximum\_<parameter name>".

A separate but related concept is the notion of range value. A range value, like the range of values, has a minimum and maximum value. It does not, however, indicate a family of parts. It indicates a parameter that may actually vary on the physical part. A range value is not a dimension that can vary within a prescribed tolerance.

**EXAMPLE** Insulation may be described as 6 inches thick, but in reality it may be 5-7 inches thick. Range values permit this to be specified.

In 4.2, the attributes that use range values are differentiated from the attributes that use value ranges by a explanatory note that follows the attribute definition.

### **L.3 Piping specifications**

As noted in clause 1, this part of ISO 10303 is intended for the exchange of references to piping specifications, not the exchange of the specification itself. However, since piping specifications are important to piping design, some aspects of piping specifications are included. The `piping_specification.owner` is the individual or organization that is responsible for its content (either as a creator or maintainer). The `piping_specification.name` is whatever useful designation the owner applies to it. The `piping_specification.piping_specification_id` is a designation that differentiates one piping specification from another (see K.1).

Service limits are specified in `piping_specification.service_description`. This is simply a narrative explanation or description of the conditions that the piping specification is applicable under. It is not the role of the piping specification to fully explicate the stream conditions. If it is necessary to exchange this information, `Stream_design_cases` may be defined.

Piping specifications identify certain families of parts that can be used given the service limits. The family of parts is specified with a `Plant_item_definition` (or, more precisely, a `Piping_component` that is also a `Plant_item_definition`) that has a special property. The parameter values for the component may be specified as a range of values.

**EXAMPLE** A piping specification may specify a family of 90-degree elbows with a centreline radius of six inches and a nominal size of between one inch and three inches. Everything about the family is same except for the variation in the nominal size.

See L.6 for a complete explanation of value ranges.

### **L.4 Catalogues items and connectors**

As noted in clause 1, this part of ISO 10303 is intended for the exchange of catalogue identifications, not the exchange of the catalogue itself. Catalogues play two roles in this part of ISO 10303:

- partial catalogue information may be exchanged. This information is limited to the identification of the catalogue and the definition of plant items contained in the catalogue. The definition of the plant items in the catalogue is exactly the same as the definition of a plant item as allowed by this part of ISO 10303.

- a plant item may be identified as being from or contained in a particular catalogue;

A catalogue may be an external, predefined catalogue or a user defined catalogue. See K for a complete explanation of how external, predefined catalogues are referenced.

Many design systems also use a catalogue-based approach for connectors. This part of ISO 10303 addresses this requirement with the application object `Catalogue_connector`. A `Catalogue_connector` behaves just like a `Catalogue_item` as described above. The exception is that since a connector (and, therefore, a `Catalogue_connector`) is a `shape_aspect`, a `Catalogue_connector` cannot be individually instantiated within an exchange file. A `Catalogue_connector` definition may be exchanged independently, but any `Catalogue_connector` instance must be part of a plant item definition. It cannot be part of a plant item instance.

## L.5 Pipe lengths

The representation of piping components within a piping design makes a distinction between two kinds of `product_definitions`: a physical `Plant_item_definition` and a `Physical plant_item_instance`. The definition is defined once and instantiated numerous times within a design at different locations to reduce duplication of information. This approach accommodates situations such as the repeated use of a pressure gauge at different locations in a design - one design, many usages.

In most piping designs, individual pieces of straight pipe of a given nominal size and material come in a large variety of lengths. Given the one design-many use approach, this would require that a definition and an instance be created for each pipe of differing length (since the length property of the pipe design shape differs). It is not practical to create `Plant_item_definitions` for each individual piece because everything about the pipe design is the same except for the length.

The use of this part of ISO 10303 permits two approaches for addressing this situation. The first is that the `Plant_item_definition` may be defined without specifying a length attribute. In this case, the length of the pipe would be associated with the `Plant_item_instance` `product_definition`. In this approach, all the information about the pipe - material, insulation, nominal size (a shape property) - would be associated with the `Plant_item_definition` `product_definition`. The shape property of the instance would be represented by (i.e., have `representation_items` of) the mapped shape of the `Plant_item_definition` (see discussion of `mapped_item`) and the parameter `end_to_end_length`.

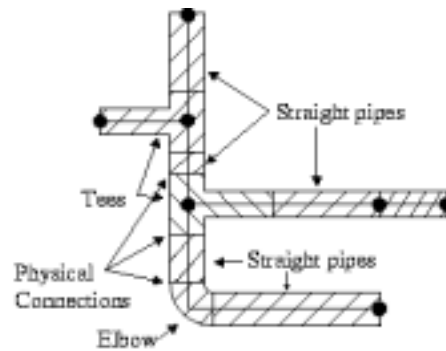
The second approach is similar to the first, but specifies `descriptive_representation_item` with the attribute `description` assigned a value of "as required", rather than specifying an `end_to_end_length`. This completely eliminates the need to specify a length and permits the pipe to be "cut to fit" at the plant site.

## L.6 Logical connectivity and relationship to physical design

Piping lines and line segments represent the logical connectivity of the process streams and equipment. This is part of a functional design in that the functional capability of the piping system is partially represented by the connectivity of the piping lines and (functional) plant items. The complete representation of the functional capabilities of the piping system is outside the scope of this part of ISO 10303. ISO 10303-221 [3] may be used to represent the complete functionality of the piping system.

The physical design of the piping is associated with the functional design of the piping lines through `line_piping_system_component_assignment`. This association links an element of the physical design (an instance, not a definition), such as a valve, to a `Piping_system_line_segment`. This association says "this piping component is on this line". Therefore, one or more piping components may be considered as being "on" a piping line.

Since physical piping components may be connected to form piping runs or piping assemblies, two kinds of connectivity can exist within a usage of this part of ISO 10303: logical connectivity represented by piping system lines and physical connectivity represented by plant item connections. In general, the only points where logical connections correspond to physical connections are where the line terminates at a piece of equipment. This is due to the fact that lines may end at equipment (by definition) and equipment connectors establish connections with piping components. Most physical connections, however, do not correspond to logical connections. Figure L.1 illustrates the relationship between the piping line segments, connectivity between line segments, physical components, and the connectivity between physical components.



**Figure L.1 - Relationship between logical connectivity and physical connectivity**

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